SCIENCE

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THE BUFFALO MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

*THE ARTISTIC ELEMENT IN ENGINEERING.**

A FRIEND of the writer, a successsful business man and much interested in things artistic, when informed of the choice of subject for this paper, gave expression to a feeling of surprise doubting if there was any relation between engineering and æsthetics.

One of the leading engineers of America once asked a professional brother what he did for recreation, and on being told of a modest interest in pictures and music likewise expressed surprise, saying, "You are the first engineer that I have ever known to be a musician." There was also an implication, though unintentional, of a diminished respect—perhaps on both sides.

These two incidents may be taken to typify in a general way the attitude that is held by the business world, on the one side, and the engineering fraternity, on the other, towards the relationship which it is proposed here to discuss.

That the artistic element is not recognized as it might or ought to be in the present American day is natural. The rapid development and growth of our land, the intensive study of science and the concentration of the efforts put forth to adapt it to everyday affairs, has exalted one phase of

*Address of the Vice-President before Section D.—Mechanical Science and Engineering.

the economic idea, the quick attainment of profitable results, and clouded the truer, broader meaning that looks toward the best things and the highest life of the people. Into the midst of this active, restless, business life entered the engineer, doing more and more of its work and becoming more and more a recognized part of it and an undisputed element in its growth. He has acquired the characteristics of the life about him, zeal, energy, alertness, readiness in meeting quickly changing conditions, and absorption in the work in hand. He plans rapidly and executes to-day with an eye for to-morrow's profits. As another has said, "The world measures the efficiency of the engineer in dollars and cents," just in fact as it measures that of any other man, and engineers, as other men, largely accept the standard.

Time was when he was only the tool of some business man who had money to expend in a certain way and who employed him, under direction, because of some individual ability. But times are changing. In place of the isolated worker there is growing up a profession with professional standards and an *esprit de corps*, and whose members are to be retained, not hired. Cultured, and with the openness and clearness of mind that only come from deep study, broad training and large experience, these are to be people of influence whose advice and services are sought, leaders, whose judgments are respected and men who can mingle with the best anywhere on a common ground of attainment and character. They are to be entrusted with the expenditure of public funds in increasing extent and with an augmenting confidence. The very nature of an engineer's qualifications, his technical knowledge, the cultivation of his judicial and critical faculty, his training in fidelity to the trusts reposed in him by private clients, all these fit him for places of large responsibility concerned with public works; and the people, tired of political management, are beginning to find this out.

These are no new thoughts, though none the less true, for others have recently written in confident strain of the coming engineer of the twentieth century. Yet it should be emphasized that the desired change is not, after all, so far ahead of us. To some extent, at least, the coming engineer has already arrived and is making himself felt. The leaven is at work.

With an engineering practice based solely on immediate results by way of expected profits in dollars and cents, the æsthetic element has little to do, though even here its absence may mean financial loss. But from the standpoint of this paper engineering is to be considered in the broader light of Telford's well-known definition: 'The art of directing the great sources of power in nature for the use and convenience of man,' while the engineer is he who designs and executes engineering works.

It is not necessary here to dwell upon the breadth and comprehensiveness of these simple fundamental statements, but let us not forget that they are broad and comprehensive. With an engineering practice based on a generous interpretation of the above, the artistic has much to do.

The engineer is primarily a designer. He works with the materials of nature as his medium and her powers as his tools, wherewith to express his thought and his purpose to serve and benefit man. Just as in the making of a picture, the brushes, paint and canvas are not the chief things, so here it is not the stone, steel and brass or the powers of gravity, steam, air and electricity that are most important, but rather the character and quality of the design and the degree of realization in its execution. The design may be bad or good, according as it ignores or harmonizes with principles underlying all such acts of cre-

ation. The result may be a happy one only when the means employed are rightly chosen and properly adapted to the end sought. In this process of creating something of value, something that helps man to a fuller, richer and better life, the artistic cannot be left out. In its absence the design falls far short of its possible perfection and man is deprived of what is due him, though not perhaps distinctly conscious of the loss. In a certain sense then every engineer is an artist, and in some directions at least, as in architecture and other forms of construction and in the making of public parks, the result of his cultured brain may attain to the dignity of a work of 'fine art.' Perhaps, in its true essence, there may be as much fine art in the design of a machine to produce bolts as there is in the making of a picture for the Salon; certainly the well-planned tool with fine proportions and parts perfectly related is above the poor canvas.

To every true man there is a joy in creation that is not satisfied with anything less than the best of which he is capable. As Emerson has said, "I look on that man as happy who, when there is question of success, looks into his work for a reply, not into the market, not into opinion, not into patronage." * * * "What is vulgar, and the essence of all vulgarity, but the avarice of reward? 'Tis the difference of artisan and artist, of talent and genius, of sinner and saint." But beyond this, which is the purely personal side of the matter, lies service, the designing for the use and convenience of man. From the vantage ground of his position as a man of educated intelligence and trained ability, the engineer owes the world his best effort. It needs and asks for technical skill and scientific knowledge whereby to-day's work may be done. But also, without knowing exactly what it wants, it feels the need of those added qualities it cannot define, and seeks for guidance and help to something better for to-morrow. In the long run, it will honor the man that meets the demand and will measure his efficiency on more grounds than that of dollars and cents.

To the superficial or hasty thinker there may appear a conflict here between the utilitarian and the artistic, but there can be no *real* antagonism. The result of an act of designing is to be judged as a whole in the light of all the purposes to be fulfilled. The physical conditions imposed by the materials used and the forces of nature employed are to be met. These conditions must be expressed in the design frankly and candidly, and in such a way as to indicate clearly its purpose and to gratify the observer through its proportions, symmetry, harmony and decoration. The end desired must be attained in the most direct and simple way, so that the expenditure of money may be a minimum. These are the three elements of design, scientific, æsthetic and the financial. A disregard of the requirements of the first may mean structural or organic weakness, on the one hand; or on the other, an excess of material that unduly adds to the cost and at the same time may produce heaviness or ugly proportions in the completed work. Non-compliance with the demands of the second makes the design fail in fulfilling its complete mission; this applies with the same force to those cases where a poorly directed attempt has been made to be artistic in expression, as to those in which no attention whatever has been paid to the matter. Artistic treatment often costs money, yet the mere expenditure of cash will not secure it. On the other hand, the proper display of good taste may often come without the spending of a dollar more than is made necessary by the other conditions surrounding the problem. A wealth of ornamentation may be brazen and vulgar, while beauty and grace may be found in the simple lines of a ma-

chine or bridge, or in the curving of the curb by the roadside. The disregard of the financial side may mean either a weak, meagre and unsatisfactory result, or an unwise lavishness in expenditure, in both cases producing in the long run a loss and waste of money.

The current engineering practice gives great attention to the first and last of these elements, and but little comparatively to the second. There is no branch of it but would be benefited by adding to scientific and business ability a knowledge of the principles of artistic design and an impulse to give expression to it. The effect on the life of our communities and the Nation by such a change is not easily estimated, The writer does not expect, however, to see an immediate revolution. This is not a change that comes naturally in that way, but rather by way of development and growth, generally slow, although it may at times be accelerated. In this development our people as a whole must increase in artistic sensitiveness. We are not an æsthetic nation, but we have latent possibilities in that direction; we are young, confident and impressionable and have the courage to be original in design, which counts for much. We have evolved the American locomotive, the American truss bridge, the American automatic machine, the American much-debated tall building, and many other things especially adapted to American needs. We shall grasp the artistic possibilities of construction quickly when we come to know what they are, and will apply them confidently, not always at first with the most happy results. We shall learn something from the old world and will assimilate much that is good in its practice, but in the end engineering here will be both artistic and American.

There are evidences here and there that this process of change is going on. American machine design when compared with that of other countries shows some marked characteristics. A writer in the *Engineering Magazine* says of these that "the best ones are directness of design, by which is meant the shortest cut to reach a given end, the designer having in mind the thing to be done quite as much as the machine which is to do it; lightness and a close proportioning of parts; in machine work a near approximation to pattern; rapidity of construction and rapidity of action in the finished machine; the substitution of special steels and new alloys, hollow construction, etc., for older materials and construction, and a generally neat appearance of work, and burrs, lips and roughness of casting removed. The American designer is not an artist like the Frenchman, but is more attentive to appearances than the Briton. He is gradually curing himself of the tendency to tawdry ornament, needless accessories of fancy castings, stenciled paints, japanning out of place and bright work for mere effect." These are good qualities and in the line of improvement. Some recent installations of power plants illustrate a movement that will have considerable influence on engine design. In many of our larger cities there are engine rooms fitted up in elegance, with marble floors and wainscott, decorated walls and ceilings, brilliantly lighted and with all the appliances of the plant, engines, dynamos, switch boards and even the smaller accessories in keeping with the surroundings. These plants are used as drawing cards or advertisements. There are other plants not so used, where there is displayed less elegance, but fully as much artistic sense in adapting the room and its treatment to its purpose. In many of these places only the enclosed type of engine can be used. In all of them the standard of maintenance must have its influence on the matter of design, which will in turn react on the

former. An engine might pound itself to death in a dark basement, but would have its slightest vagary looked after in one of these better planned housings. This result cannot be entirely accounted for by the larger room, the better light, the rules and regulations. There is a refining, educating influence in these artistically planned constructions that makes better men and more efficient workmen of the attendants. Whatever they may cost, there is a credit side to the balance sheet.

Our railways are contributing toward this change. They have found the decoration of passenger trains a profitable thing and, so stimulated, have carried it to excess. Handsome terminal stations, adorned in good taste, are supplanting the dingy, forbidding and inconvenient places so long in use, while the shed type of depot is being crowded out by beautiful, quaint buildings set in the midst of lawns and flower beds. More significant still is the tendency to adopt a high standard of maintenance, under which the roadbed is kept trim and neat, flanked by sodded slopes and bordered by clean and well-kept buildings; which also requires the rolling stock, the shops and yards to be maintained in a high state of efficiency. This is not necessarily in itself artistic, but it furnishes at least a necessary foundation. That the railway management understands, to some degree, the commercial value of the artistic element in its business is further evidenced by the nature of its advertising, that seizes on any advantage of scenery or artificial effect that is at hand.

Not much can be said in praise of the artistic qualities of our bridges, for these attributes are conspicuous through their absence. The American bridge satisfies the conditions of stability and least cost, but of beauty of line or balanced proportion that make it fit into and harmonize with the landscape or even that makes it attractive considered by itself, it has little. And this is to be the more regretted because an intelligent application of right principles would much improve the effect, without adding much, if any, to the cost or making the structure less safe and durable. It is true that the truss with parallel chords, especially of the through type, does not lend itself readily to artistic treatment, yet even here something can be done. It is not so much a matter of adding ornament as the proper treatment of the organic lines, the length of spans, the relation of length of panel to height of truss, the location of the piers and the form of their outlines. Ornamentation is not to be used so much for its own sake, but rather where it is needed to accentuate these organic markings. There are some truss bridges of such size that they give pleasure to the observer through their massiveness, though lacking in other desirable qualities. The cantilever, like the Pratt and its relatives, is difficult of treatment, while arch forms, either braced or of the suspension type, are naturally pleasing and best adapted for artistic expression. Of these types we have a few satisfactory examples, like the Eads and the Grand Avenue bridges at St. Louis, the Brooklyn and Washington bridges at New York. In our public parks are to be found many small bridges of good design, while in our cities there are some creditable ones of larger dimensions. There is some tendency toward the use of curved chords in bridges designed for urban use, and a further evidence of interest in the curved line through the introduction of the Melan arch. In some respects it is unfortunate that the economical element has driven out the stone arch, which possesses so many of the elements of a beautiful structure for most situations, and it may be that this new form will become a substitute for the old, with added characteristics of its own. However much we may admire the inventive genius and mechanical ingenuity

of those who have worked out the types of rolling or lift bridges that cross the Chicago river, the less said about the beauty of the designs the better. Perhaps the environment imposes ugliness on the designer. But that problem is hardly solved yet, and will not be, until some man gets hold of it that combines æsthetic with scientific qualities and has insight keen enough to see the possibilities of the situation and adroitness enough to manage, not only the physical, but also the human factors—a rare combination.

In the entire field of engineering there is no portion of it that includes a greater variety of intricate and difficult problems for solution than that connected with municipal life. Here the engineer has to do with matters touching the home life; the dwelling, its heating, ventilation and lighting, its drainage and water supply, etc. There is the business life that demands attention for the stores, office blocks, banks and exchanges, manufactories and shops, warehouses and elevators with all of their requirements of heating, cooling, lighting, ventilation, drainage, power and internal communication through elevators, pneumatic systems and alarms. Then there is the larger life of the city as a whole that needs public buildings, churches, schools, hospitals, libraries, museums, hotels, theaters, railway stations and markets, each with its own peculiar demands; streets and systems for rapid transit, both intramural and suburban; the distribution of water, heat, cold, light and power; pneumatic systems for carrying packages; electrical conduits; sewerage and garbage systems, with the plants for their treatment or disposal; wharves and railway yards; parks, boulevards, play grounds, plazas; the opening of new territory to accommodate the city's growth.

The engineer here comes in close contact with the people that daily and hourly use the results of his work. He already influences their health and bank accounts for the better, gives them greater ease and convenience at work or play and saves their time. This is what is asked of him and he meets the demand well. But what an uplift would come to city life, how much richer it would be, if he could put an artistic quality into his designing and the people would learn to appreciate it. It is not to be inferred that there is an entire absence of this, but rather that artistic effects have been largely confined to individual cases, and not made manifest in the general life of the city. For instance, there are numerous examples of suburban dwellings, beautiful internally and externally and with harmonious settings; there are occasional business blocks whose treatment is satisfactory, but very few public buildings that have an adequate artistic meaning and are so situated as to express this advantageously if they did posssss it. Without detracting in the least from the acknowledged merits of Trinity Church, Boston, it must be admitted that its roomy location on one side of an open plaza adds greatly to its effectiveness. Think of its being placed in the middle of a block on Washington street, or set in the midst of brownstone fronts on Fifth avenue! All public buildings need both room and an appropriate setting. They are the larger and more important pictures in the gallery of city structures; yet under the prevailing system of rectangular blocks, bounded by long, straight and narrow streets, the hanging committee has nothing but the walls of corridors on which to place them. The worst of the matter is that the exhibition is a permanent one. Along these alleyways must also be hung the narrow, vertically elongated panels that seem to be so popular to-day, in favor because they pay. The observer needs a twenty story ladder in order to study their details or even to know if they have any and

can find no point from which they can be seen as entireties. At their sides hang strings of pictures whose horizontality exaggerates their skyward tendency. It is not the modern tall building in itself that is here objected to, but its location on sites that will not admit of a display of its best qualities. With wide, clear surroundings and effective grouping they may be made agreeable, as is illustrated by the happy combination at the southeast corner of Central Park.

One of the good results of the tall building craze is the bringing closer together of two branches of designers; from the architect the engineer will learn more of art and he will teach the former better construction. While retaining their separate functions, the collaboration will result in a higher mutual respect and appreciation and a better grade of work on the part of each.

It is undisputed that the rectangular plans of American cities are neither adapted to meet æsthetic conditions nor the demands of traffic. The long streets, without variation in width and direction and without the breaks afforded by little parks, are tiresome to the eye. They are not placed with any regard to the topography or the natural features of the landscape or to give prominence to some important structure, nor do they furnish direct lines of travel. But the plan is weighted down to the ground by millions of money. So it is not a question of what it ought to be, but one of mitigating the present evils and avoiding a repetition of these in the future. Radical treatment must be resorted to by way of diagonal avenues from congested centers and the widening out of the intersections of important streets into parks and plazas. There must likewise be a heroic struggle with the water fronts and internal water courses, places full of picturesque possibilities, though usually given over to filth and ugliness. These changes are made imperative not only by aesthetic requirements, but also by the demands of health and business.

In the planning of additions to large cities, the designer is hampered by the supposed necessity of tying to the older plans, by the desire of owners and speculators to realize to the largest extent on the sale of lots, or by his uncertainty as to what the future growth and character of the population may be. An examination of the block plan of many of our cities would show a heterogeneous arrangement of streets, especially in outlying districts, without regard to mutual relations, matters of grade and drainage or artistic position. This irregularity may be more inconvenient and less pleasing than a right-angled plan. Our towns and smaller cities reproduce in miniature the conditions of the larger centers. Here again it is a question of improvement instead of original design, only the problems involved are not so intricate and their solution not so costly. So it is hardly possible for a designer to plan an ideal city or to have the full swing and liberty of the men who laid out the city of Washington and established its system of grades and drainage. But in spite of difficulties there exist some suburban districts, laid out, built up and adorned on the principles of good taste. Thanks to the systems of rapid transit that are increasing the number of these attractive places!

In the design and maintenance of water supply plants, American practice shows some respect for the artistic element. This is not confined to any particular system or any part of any one plant, but is quite general. The engine houses are not ugly and their interiors are often attractive. Gate houses, aqueducts and dams are decoratively treated and form pleasing features in the landscape. The slopes of reservoirs are kept trimmed and the grounds

generally turned into lawns with flower beds and perhaps a fountain. No doubt, the sanitary conditions imposed have much to do with this, but the result is none the less in good taste. We cannot avoid, however, a stray shot at the ugly standpipe with conical cap, sometimes seen in our smaller towns. This is unnecessary. When enclosed it has been made an interesting object, and even the bare pipe can be ornamented in such a way as to relieve its nakedness.

There is much encouragement in the growing appreciation and enjoyment of public parks and boulevards. Cities and towns all over the land are trying to beautify what they already have and are adding new territory to their park resources. Admirable skill has been shown in utilizing the natural features of the local landscape, the rocks, tree masses, meadows, ravines, ponds and streams, the wide expanse of ocean or glimpses of bright water. The curving roads and paths, with undulating gradients, have a beauty of their own and lead one from point to point of the ever-changing scene, and yet bind it all into one harmonious whole. While the landscape engineer deserves credit, not so much praise can be given park commissioners for the artificial adornments which they have added to his work. Notwithstanding the fact that these are sometimes labeled as artistic, they do not always fit in appropriately.

The writer firmly believes that there is a latent æsthetic quality in American life that is now struggling to find both means for its gratification and methods of expression. Before there can be knowledge of its meaning and power there must be many attempts and many failures. The whole process is one of education and that largely in the school of experience. This applies to the industrial and constructive arts as well as to the fine arts. The engineer will share in the general movement, but this is not enough. As a designer of so much that the world needs for daily use he must do more than keep up; he must keep in advance. He must not only have a capacity to enjoy, but also the power to originate and apply. To this end he must give preliminary study and thought to the principles of æsthetic design, so gaining an intellectual knowledge of them. American engineering schools are doing little or nothing to help the young engineer to this. So far as the writer knows, there is but one American text-book, Prof. Johnson's book on bridges, that includes any discussion of the matter. A course of study in engineering æsthetics near the close of college life would be a great help and stimulus to a young graduate, at least opening his eyes to the fact that there was such a thing. After knowledge comes the application of principles as tests to an engineer's own work and to that of other men. And, finally, with theoretical and practical knowledge well in hand and a love of what is beautiful, comes the impulse to work artistically. With such engineers and an appreciative clientele American engineering would be artistic. To this end let us work.

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GEOLOGICAL MYTHS.*

MANY years ago I visited the British flagship 'Bellerophon' in the harbor of Bermuda, and was told that when the ship was first named the sailors wrestled with the sonorous but unmeaning name, and quickly transformed it into 'Billy-ruffian,' and it became at once intelligible, and belligerent, and satisfying.

There arose, however, a contest in the forecastle as to whether 'Billy-ruffian' or 'Bully-ruffian' was the correct thing; certain rude fellows of the baser sort wish-

* Address of the Vice-President before Section E, Geology and Geography.

ing to have the word pugnacious in both its proximal and distal extremities.

This illustrates the principle of attraction in language whereby words without meaning to the users tend to be modified into forms which at least appear intelligible.

It is said that when asparagus was introduced into England the peasants immediately called it 'sparrow-grass,' and went on to explain the reason it was called sparrow-grass was because the sparrows ate the red berries.

This illustrates the second step of the process. The word is first attracted into a form which has a meaning, and in its turn this meaning requires a justification, and this the meaning itself quickly suggests.

The peasant was not disturbed by, or did not observe, the fact that the sparrows do not eat the red berries. This would have been to have risen to the 'verification of hypothesis'—an indefensible encroachment on the terrain of the British philosopher.

I propose to trace the history of several myths which have their origin in remarkable geological phenomena, for I hardly need to say that I do not use the word myth in the modern fashion of newspaper English, as a false report, a canard, in short, a newspaper story; but as meaning a history, treasured and hallowed in the literary and religious archives of an ancient folk, of some startling or impressive event, that, in the stimulating environment of poetry and personification, has completed a long evolution, which disguises entirely its original,—

> " Has suffered a sea-change
> Into something new and strange,"

so that, in fact,its study is paleontological.

I propose to speak of the Chimæra, or the poetry of petroleum; of the Niobe, or the tragic side of calcereous tufa; of Lot's wife, or the indirect religious effect of cliff erosion, and of Noah's flood, or the possibilities of the cyclone and the earthquake wave working in harmony.

THE CHIMÆRA.

The myth of the Chimæra is told, in its earliest form, in a quaint old translation of Hesiod, who, according to the Marbles of Paros, lived about nine centuries before the Christian Era.

> " From the same parents sprang Chimæra dire,
> From whose black nostrils issued flames of fire;
> Strong and of size immense; a monster she
> Rapid in flight, astonishing to see;
> A lion's head on her large shoulders grew,
> The goats and dragons terrible to view;
> A lion she before in mane and throat,
> Behind a dragon, in the midst a goat;
> Her Pegasus the swift subdued in flight
> Backed by Bellerophon, a gallant knight,
> From Orthus and Chimæra, foul embrace,
> Is Sphinx derived, a monster to the race."

The same story is told a little later by Homer* with more grace of diction.

> " And Glaucus in his turn begot
> Bellerophon, on whom the gods bestowed
> The gifts of beauty and of manly grace.
> But Proetus sought his death; and mightier far,
> From all the coasts of Argos drove him forth.
> * * * * *
> To Lycia, guarded by the gods, he went;
> But when he came to Lycia and the stream
> Of Xanthus, there with hospitable rites
> The king of wide-spread Lycia welcomed him.
> Nine days he feasted him, nine oxen slew;
> But with the tenth return of rosy morn
> He questioned him and for the tokens asked
> He from his son-in-law, from Proetus bore
> The token's fatal import understood,
> He bade him first the dread Chimæra slay,
> A monster sent from heav'n—not human born,
> With head of lion and a serpent's tail,
> And body of a goat, and from her mouth
> There issued flames of fiercely-burning fire.
> Yet her, confiding in the gods, he slew.
> Next with the valiant Solymi he fought
> The fiercest fight he ever undertook;
> Thirdly the women-warriors he overthrew,
> The Amazons."

It will be seen here that Bellerophon, like Hercules or St. George, is a professional wandering slayer of dragons. His

*Iliad., VI., 180; Earl Derby's Translation, VI., 184-216.

name from βάλλω, the far-throwing rays of the sun, shows him to be a type of the wide-spread sun-myth, whose rising rays strike down the forms of darkness.

But the myth of Chimæra is independent of him, and is always localized; there is always the tail of a dragon, the body of a goat and the head of a lion, or the three heads of lion, goat and serpent, and it vomits fire, and ravages in the mountains of woody Lycia.

The classical prose writers describe the phenomenon with curious accuracy. Seneca says:

> "In Lycia regio notissima est.
> Ephestion incolæ vocant,
> Perforatum pluribus locis solum,
> Quod sine ullo nascentium damno ignii innoxius circuit.
> Laeta itaque regio est et herbida nil flammis adurentibus."

(In Lycia is a remarkable region, which the inhabitants call Ephestion.* The ground is perforated in many places; a fire plays harmlessly without any injury to growing things. It is a pleasant region, therefore, and woody, nothing being injured by the flames.)

Strabo says, simply: "The neighborhood of these mountains is the scene of the fable of the Chimæra, and at no great distance is Chimæra, a sort of ravine, which extends upward from the shore." And Pliny, with his accustomed mingling of truth and fiction, says: '— et ipsa (Chimæra sæpe flagrantibus jugis' (and Chimæra itself with its flaming peaks). And again: "Flagrat in Phaselide Mons Chimæra et quidem immortali diebus ac noctibus flammâ." (Mount Chimæra burns in Phasilis with a certain immortal flame shining by day and by night.) Also: "In the same country of Syria the mountains of Hephæstius, when touched with a flaming torch, burn so violently that even the stones in the river and the sand burn while actually in the water. This fire is also increased by rain. If a person make furrows in the ground with a stick which has been kindled at this fire, it is said that a stream of flame will follow it."

* That is Vulcan.

Servius, the ancient commentator of Virgil, explains the myth as follows: "The flames issue from the summit of the mountain, and there are lions in the region under the peak, the middle parts of the hill abound with goats, and the lower with serpents." While the modern commentators say: "The origin of this fire-breathing monster must be sought probably in the volcano of the name of Chimæra in Phaselis, in Lycia,"* and the myth did not escape the great, but largely wasted, erudition of Knight, who says: "In the gallery in Florence is a colossal image of the Phallus, mounted on the back parts of a lion, and hung round with various animals. By this is represented the cooperation of the creating and destroying powers, which are both blended and united in one figure, because both are derived from one cause. The animals hung round show also that both act to the same purpose, that of replenishing the earth, and peopling it with still rising generations of sensitive beings. The Chimæra of Homer, of which the commentators have given so many whimsical interpretations, was a symbol of the same kind, which the poet, probably having seen in Asia, and not knowing its meaning (which was only revealed to the initiated), supposed to be a monster that had once infested the country. He described it as composed of the forms of the goat, the lion and the serpent, and breathing fire from its mouth, (Il. V., 233). These are the symbols of the creator, the destroyer and the preserver, united, and animated by the fire, the divine essence of all three.

"On a gem published in the Memoirs of

* Smith's Dict. of Clas. Antiq. Sub. Chimæra.

the Academy of Cortona this union of the destroying and preserving attributes is represented by the united forms of the lion and the serpent crowned with rays, the emblems of the cause from which both proceed. This composition forms the Chnoubis of the Egyptians." *

And thus the matter rested until, in the end of the last century, Admiral Beaufort,† while anchored off Lycia on hydrographic work, saw each night a strong flame on the peak of a mountain a few miles back from the coast, and was told by the inhabitants that it had always burned there.

He visited the place, and found flames of natural gas issuing from a crevice on a mountain of serpentine and limestone.

In 1842 Spratt and Forbes ‡ report as follows on the locality: Near Ardrachan, not far from the ruins of Olympus, a number of serpentine hills rise among the limestones, and some of them bear up masses of that rock. At the junction of one of these masses of scaglia with the serpentine is the Yanar (or Yanardagh), famous as the Chimæra of the ancients, rediscovered in modern times by Captain Beaufort. It is nothing more than a stream of inflammable gas issuing from a crevice, such as is seen in several places among the Apennines. The serpentine immediately around the flame is burned and ashy, but this is only for a foot or two; the immediate neighborhood of the Yanar presenting the same aspect it wore in the days of Seneca, who writes "Læta itaque regio est et herbida, nil flammis adurentibus."

Such is the Chimæra, 'flammisque armata Chimæra,' § deprived of all its terrors. It is still, however, visited as a lion by both Greeks and Turks, who make use of its classic flames to cook kabobs for their dinner.

In 1854 it was visited by the Prussian painter, Berg, who has reproduced the scene in a fine painting now in Berlin.* The flame which he says, gives the odor of iodine, is three or four feet high. Several extinct openings were found in a pool of sulphurous water.

The Austrian geologist, Tietze,† found the flame two feet across, and a smaller one adjacent. The ruins of an ancient temple of Vulcan, near by and of a late Byzantine church, show how strongly it has impressed the inhabitants in all ages.‡

The natural phenomenon of a spring which is found by historic documents to have been burning for nearly three thousand years is sufficiently striking, although the slow escape of such gas from Tertiary limestones is not uncommon. The mention of sulphurous waters in the neighborhood may justify us in going back to the same antiquity and drawing from the remark of Theophrastus (Περὶ τῶν λίθων) on the oxidation of pyrite in contact with bitumen, an explanation of the constant ignition of the gas.

Theophrastus says: "That, also, which is called Epinus (or Spelus) is found in mines. This stone cut in pieces and thrown together in a heap exposed to the sun, burns, and that the more if moistened or sprinkled with water."

We may of course assume the more prosaic spontaneous combustion of the volatile hydrocarbons to explain the constant rekindling of the sacred fires.

It remains to consider how the myth and its name arose. The mountain is still called Yanar-dagh, the burning mountain, and in a learned work on coins of Sicyon, which

* Richard Payne Knight. Discourse on the Worship of Prapus, p. 73.

† Beaufort's Karamania, 35, 52, 85.

‡ Travels in Lycia, II., 181, 1847.

§ Virgil, Æneid, VI., 288.

* Zeitschrift, All. Erdkunde, III., 307.

† Beiträge, zur Geologie Lykien. Jahrbuch d. K. K. Geol. Reichsanstalt, XXXV., 353.

‡ C. Ritter, Erdkunde, Theil. 19, 751.

reproduces the Chimæra, M. Streber derives the name from the Phœnician word Chamirah, which means the burning mountain.

But the Greek word χαμαίρα means a goat, and has almost the same sound, and we can see clearly how, as the Greek settlements spread over Lycia, from the north, the meaningless Phœnician names were retained like the Indian names in America, and how the story slowly went back to the fatherland—et crescit eundo—of a strange mountain called Chamira, from which portentous flames escaped, and then of a monster Chimæra, of goat-like form, vomiting flames and ravaging in the mountains of woody Lycia. And so the story was finally fitted for the manipulation of the poets, who little thought they were making the stout Bellerophon run a quixotic tilt against a burning gas well.

THE NIOBE.

Like the Chimæra, the Niobe is an episode in Greek mythology, easily separated from the rest without disturbing the Greek Pantheon. I do not need to describe the great group of the Niobe, the mother weeping over her children, who fall before the shafts of Apollo, which adorns the gallery of the Uffizi at Florence, and forms one of the masterpieces of Greek sculpture, the glory of Scopas or Praxiteles. I do not need to recall the story as told by Homer, how Niobe, the daughter of Tantalus, proud of her twelve children, despised Latona, who had but two; how, therefore, Phœbus and Artemis slew all the twelve with their arrows:

"They lay unburied on the plain for nine days, when Zeus changed them to stone, and on the tenth day the heavenly gods buried them. And now, upon arid Sipylus, upon the rocks of the desert mountain, where, they say, are the couches of the divine nymphs, who dance upon the banks of Achelous, Niobe, though turned to stone, still broods over the sorrow the gods have sent upon her."

And Ovid says:

"She weeps still, and borne by the hurricane of a mighty wind,
She is swept to her home, there fastened to the cliff of the mount,
She weeps, and the marble sheds tears yet even now."

As one climbs from the Gulf of Smyrna, between Mount Tmolus and Sipylus, up the rich valley of the Nif, or Nymphio, there appears, high up in the vertical wall of limestone, the colossal bust of a woman standing on a high pedestal and in a deep alcove. It is cut out of the living rock, like the Swiss lion at Lucerne.

A recess twenty-five feet high and sixteen feet wide has been cut in the rock for the lower part, and a smaller alcove of much greater depth surrounds the bust itself. All the face of the rock around is smoothed, and a broad ledge is cut around the pedestal to receive the offerings of the ancient Phœnician worshippers of this almost prehistoric statue of the great Mother Cybele, or of Meter Sipylene; gods of the Phœnicians.

From the valley below it makes the impression of a full-length statue with flowing robes, but near at hand the robes are seen to be the very tears of Niobe, formed where the drip of the waters from the limestone roof of the alcove has first struck her cheeks, and running down across her breast has made rippling surfaces of bluish tufa, which has all the effect of tears.

The statue had been greatly corroded, and the stalagmite tears had formed already in the days of Pausanias, who says: "When standing close to it the rocks and precipice do not show to the beholder the form of a woman, weeping or otherwise, but if you stand farther back, you think you see a woman weeping and sad."

And even in the times of Homer the mem-

ory of the earlier and vanished worshippers was at best a dim tradition, and the facile imagination of the Greeks had built up the whole beautiful legend, every element of the surrounding scenery adding its portion of suggestion, and it is marvellous how all parts of the story still linger in the valley.

As the grand missionary, artist and geologist, van Lennep, from whom I have obtained most of this account,* who in all his travels in Asia Minor collected carefully and labelled carefully, and sent valuable material to his Alma Mater, Amherst, was climbing to the statue, his guide, a cake-seller by the roadside, said : "There is a tradition that this statue was once a woman, whose children were killed, and she wept so that God changed her to stone. They say that her tears make a pond down there, and still keep it full."

All the people of the region, ignorant and learned, agree in this, while all travellers have called this the statue of Cybele.

Their name for the valley, Nif, is a corruption of Nymphio, as Homer says, 'the couches of the divine nymphs.' Sipylus, the name of the mountain to this day, was also the name of the oldest son of Niobe.

Niobe was the daughter of Tantalus. Tantalus, from *ταλαντεύω*, to balance, is a rock poised in the air, an allusion to the ledges overhanging the statue, and threatening to fall and crush it.

That she is the mother of many children may be a reminiscence from Cybele, the All-mother, and the mention of the couches of the divine nymphs seems to suggest some ancient nature worship of the valley. The children slain by the arrows of Phœbus are the masses of rock dislodged from the cliffs around her by the action of sun and rain and forming the great talus at the foot of the bluff.

"They lie unburied on the plain," Homer tells us, "till on the tenth day the heavenly gods bury them," as the fallen rock quickly disintegrates under the influence of the weather in this warm climate. The Greek word, Niobe, connects itself with the pouring of water and the falling of snow (*νίζω νίπτω* and *νίφω*), so a Greek impersonation of the drip from the marble cliff upon the ancient rock sculpture might easily have acquired the name of Niobe, the weeping one.

*Asia Minor, II., 300. London, John Murray, 1870.

"It seems, thus," says van Lennep, "that this sculpture was executed in a very remote antiquity, to represent Cybele, the mother of the gods, or some form of nature-worship, that the water drip from the rock above gave it, from the first, the same striking watermark which it still bears, maintained by the same cause, and that this appearance suggested to the lively imagination of the Greek the whole myth of Niobe—her tears, her sorrows, her strange transformation, her perpetual weeping; so this most ancient statue is not an image sculptured to represent this story of Niobe, but is itself the very original from which the story sprung." It is thus an impressive testimonial of the vast importance of the loose bond by which the second molecule of CO_2 is held combined in calcic bicarbonate.

LOT'S WIFE.

Looking down on that most marvellous of all lakes—the Dead Sea, the Lacus Asphaltites of the Romans—the sea of Lot of the Arabs, still stands the great column of salt into which Lot's wife was changed.

"She was changed into a pillar of salt," says Josephus, "for I have seen it, and it remains to this day."

And Irenæus explains how it came to last so long with all its members entire, because "when one was dissolved it was renewed by miracle." It was, in fact, the geological miracle of erosion.

The column looks down from the plain of Sodom, and on the great southern bay

of the sea, ten miles square, and but one or two feet deep, where sulphur, deposited by many hot springs, is abundant in the clay, and where bitumen oozes from every crevice of the rock, and every earthquake dislodges great sheets of it from the bottom of the lake, where the Arabs still dig pits for the 'stone of Moses' to gather in, and sell it in Jerusalem, and where, in that most ancient fragment of the Pentateuch, four kings fought against five, and the kings of Sodom and Gomorrah slipped in the slime-pits and fell. One who has read of the burning of an oil well or Oil Creek, or in Apscheron will have a clear idea of the catastrophe which overtook the cities of the plain where the Lord rained upon Sodom and upon Gomorrah brimstone and fire out of Heaven.

Following the latest extremely interesting researches of Blankenkorn,* we may picture the upper cretaceous plateau of Judea—an old land, cleft at the end of the Tertiary by many faults, between which a great block sank to form the bottom of this deep sea. It carried down in the fossiliferous and gypsum-bearing beds the source of the bitumen and the sulphur. We may picture the waters standing much higher than now during the pluvial period, which matched the northern glacial period, rising nearly to the level of the Red Sea, but never joining it. In the succeeding arid interglacial period, the time of the steppe fauna in Europe, the sea shrank to within a hundred meters of its present level, and deposited the great bed of rock salt which underlies the low plateaus around its southern end. The advent of the second glacial period was here the advent of a second pluvial period, which swelled the waters and carried the bitumen-cemented conglomerates over the salt beds to complete the low plateau. After the second arid period with some lava flows, and a third pluvial period with the formation of a lower and broader terrace, the waters shrank to the present saturated bitterns in the present arid period. In the earlier portion of this last or post-glacial stadium, a final sinking of a fraction of the bottom of the trough, near the south end of the lake, dissected the low salt plateau, sinking its central parts beneath the salt waters, while fragments remain buttressed against the great walls of the trench forming the plains of Djebel Usdum and the peninsula El Lisan, with the swampy Sebcha between. Imagine a central portion of one of the low plains which extend south from the 'Finger Lakes' to sink, submerging Ithaca or Havana in a shallow extension of the lake waters. It exposed the wonderful eastern wall of Dijebel Usdum, seven miles long, with 30–45 m. of clear blue salt at the base, capped by 125–140 m. of gypsum-bearing marls impregnated with sulphur, and conglomerates at times cemented by bitumen. It was this or some similar and later sinking of the ground, at the time when geology and history join, which, with its earthquakes, overthrew the cities of the plain and caused the outpour of petroleum from the many fault fissures and the escape of great volumes of sulphurous and gaseous emanations, which, ignited either spontaneously, by lightning or by chance, furnished the brimstone and fire from heaven, and the smoke of the land going up as the smoke of a furnace which Abraham saw from the plains of Judea.

But with Lot's wife the case is different. The bed of salt out of which she was carved, and has been many times carved, was exposed by the very catastrophe which destroyed the cities; and Lot fled to Zoar in a direction opposite to that in which the salt bed lies. As Oscar Fraas found his Arabs calling the salt pyramid 'Lot's col-

* Dr. Max Blankenkorn, Entstehung und Geschichte des Todten Meers. Zeit. Deutsch. Palestina-Vereins, vol. xix., p. 1, 1896.

umn,' so, in early times, when the tradition of the burning cities was gradually growing into the myth of Sodom and of Lot, some old name of the salt column, grown meaningless, may have had such sound as to suggest the term, 'Lot's wife'—Bint Sheck Lut, or the woman's own name in the current language, as Chamirah, the burning mountain, suggested Chamæra, the goat, and the answer to the question why was the salt column called Lot's wife was quickly given and woven into the legend. In that dry climate successive erosions have reproduced it along the seven-mile ridge of salt, still called Kashum Usdum, or Sodom.

THE FLOOD.

Only through an exegesis of the German words Alluvium and Diluvium would the young geologist be reminded of the time when the Flood was a burning question in geology, an igneo-aqueous question, so to speak; when commentaries explained the fossil shells in the Apennines as due to Noah's Flood, and Voltaire tried to break the force of this important proof of the truth of the Bible by declaring these shells to be the scallop-shells thrown away by expiring pilgrims of the Crusades; when Andreas Scheuzer apostrophized his fossil salamander ('Homo diluvii testis et theoscopos'):

"Betrübtes Beingerüst von einem alten Sünder
Erweiche Stein und Herz der neuen Bösheits-kinder."

This ancient sinner's scattered and dishonored bones
Should touch the stony hearts of modern wicked ones.

It was thus a great surprise when one of the most powerful and philosophical works of the century on geology, 'Die Ansicht der Erde,' of Suess, had as its opening chapter an explanation of the Flood as due to a coincidence of a cyclone and an earthquake at the mouth of the Euphrates. The Biblical account is plainly exotic, told by a people ignorant of sea-faring—a fresh-water account of a salt-water episode. The description of the vessel as a box or ark, the going in and shutting the doors, and the opening of the windows, remind one of a house-boat and indicate the adaptation of the story to the comprehension of an inland people. Its minor discrepancies and blending of the Jahvistic and Elohistic elements show the story has come by devious courses from a distant source.

The account of the Chaldean priest, Berosus, 250 B. C., located the occurrence at the mouth of the Euphrates, where the native boatman still pitches his boat within and without with pitch, as the ark was pitched.

Berosus, priest of Bel, quoted by Alexander Polyhistor, says that the Flood occurred under the reign of Xisuthros, son of Otiartes. Kronos announces to Xisuthros, in a dream, that on the fifteenth of the month Daisios all mankind shall be destroyed by a flood. He commands him to bury the writings containing the records of the history of his country at Sippara, city of the dead, then to build a vessel, to stock it with provisions, then to embark with his family and his friends, also to take quadrupeds and birds with him.

Xisuthros obeys the command. The Flood occurs and covers the land; it decreases; he lets out birds to gain knowledge of the state of things, and finally leaves the ship and prepares with his family, an offering to the gods. Xisurthros is then, for his piety, translated to live among the gods, with his wife, his daughter and the steersman. Of the ship of Xisuthros, which finally stranded in Armenia, there still remains a portion in the Cordyaian Mountains in Armenia, and the people scrape off the bitumen with which it is covered, and use it as an amulet against sickness. And as the others had returned to Babylon and had found the writings at Sippara they built towns and erected temples, and so Babylon was again peopled.

Twenty years ago George Smith excavated and translated the inscribed tiles of the library of Asurbanipal, King of Assyria, 670 B. C., who, at the time of the founding of Greece, was gathering copies of the sacred writings of the ancient cities of Asia. The historical books of this library carry the annals of the Babylonians back 3800 B. C., but contain no certain account of any flood. How remote must then have been the great catastrophe which had filtered down in tradition and become embalmed in sacred myth and stately poem before the dawn of history! I present here, after the latest translations of Haupt and Jensen,* the last but one of the cantos of the Gilgamos Epic, corresponding to the eleventh sign of the zodiac, Aquarius (or month of the curse of rain), containing the story of the Flood.

Gilgamos (= Nimrod), the hero of Urruh, leaves his native town sick and troubled by the death of his friend Eabani, and visits his ancestor Samasnapisthim (= Xisuthros) called Hasisadra (= the devout wise man). Hasisadra spoke to him, to Gilgamos, "I will make known unto thee, O Gilgamos, the hidden story, and the oracle of the gods I will reveal to thee. The city of Shuripak, —the city which, as thou knoweth, lies on the bank of the river Euphrates—this city was already of high antiquity when the gods within set their hearts to bring on a flood storm (or deluge). Even the great gods who were there: their Father Anu; their councillor, the warlike Bel; their thronebearer, Adar; their prince, Ennugi. But the Lord of unfathomable wisdom, the god Ea (the god of the sea), sat alone with them in council, and announced their intention unto the field, saying, Field! Field! town! town! field! hear! town; give attention, O man of Shurippak, son of Ubara-Tutu (The splendor of the Sunset, Lenarmont, Sayce). Destroy thy house, build a ship, save all living beings which thou canst find. Withdraw from what is doomed to destruction. Save thy life and bid the seed of life of every kind mount into the ship.

"The vessel which thou shalt build, 600 half cubits in length, shall be her shape, and 120 half cubits the dimensions for both her width and depth. Into the sea launch her. When I understood this, I spake unto the god Ea—My lord thy command which thou hast thus commanded, I will regard it, I will perform it, but what shall I answer the city, the people, the elders? (The young men and the elders would ridicule me.)

"The god Ea opened his mouth and spake unto me, his servant: 'And thou shalt thus say unto them, "I know the god Bel (the god of Shurippak) is hostile to me, so I cannot remain in (the city); on Bel's ground I will not rest my head. I will sail into the deep sea; with the god Ea, my lord, I will dwell." But upon you there will pour down a mass of water. Men, fowl, and beast will perish, the fish only will escape. * * * And when the sun will bring on the appointed time Kukki will say, "In the evening the heavens will pour down upon you destruction."

"'Then, however, close not thy door until the time comes that I send thee tidings. Then enter through the door of the ship, and bring into its interior thy food, thy wealth, thy family, thy slaves, thy maidservants and thy kindred. The cattle of the field, the wild beasts of the plains * * * will I send you, that thy gates may preserve them all.'

"Hasisadra opened his mouth and spake. He said to Ea, his lord: 'No one has ever built a ship in this wise on the land. However, I will see to it, and build the ship upon the land, as thou hast commanded.' (The description of the building of the vessel very partial.) I built the ship in six

* Haupt: in Die Ansicht der Erde. The first part from a later translation; Johns Hopkins' Circulars (VII., No. 69, p. 17), P. Jensen in Dr. Carl Schmidt, Das Naturereignis der Sintflut.

stories. I saw the fissures, and added that which was lacking. Three sars of bitumen I poured upon the outside, three sars of bitumen I poured upon the inside. (Thirteen lines of description illegible.) The vessel was finished. All that I had I brought together, all that I had in silver I brought together. All that I had of gold I brought together. All that I had in living seed I brought together. And I brought all this up into the ship, all my manservants and my maidservants, the cattle of the field, the wild beast of the plain, and all my kindred, I bade embark.

"As now the sun had brought on the appointed time, a voice spake: 'In the evening the heavens will rain destruction. Enter into the interior of the ship and shut the door. The appointed time is come.' The voice said, 'in the evening the heavens will rain destruction.' With dread I looked forward to the going down of the sun. On the day appointed for embarking I feared (greatly). Yet I entered into the interior of the ship and shut to my door behind me to close the ship. To Buzurbil, the steersman, I gave over the great structure with its load. Then arose Museri-ina-namari from the foundations of the heavens; a black cloud, in whose middle Ramman (the weather-god) let his thunder roar, while Neba and Sarru rush at each other in warfare.

"The Throne-bearers stalk over mountain and land,
The mighty god of pestilence let loose the whirlwinds (?)
Adar lets the canals overflow unceasingly.
The Anunnaki raise their torches,
They make the earth glow with their radiant gleams.
Ramman's inundating wave rises up to heaven,
All light sinks in darkness.
In a day they lay waste the earth like a plague, the winds raging blow.
Mountain high they bring the waters to fight against mankind.
The brother sees the brother no more,
Men care no more for one another.
In heaven the gods fear the deluge and seek refuge.
They mount up to the heavens of the god Anu.
Like a dog in its lair the gods crouch at the windows of heaven.
Istar (the mother of mankind) cries like a woman in childbirth,
The sweet-voiced queen of the gods cries with loud voice:
'The dwelling place of mankind is reduced to slime.
That has come which I announced before the gods as an approaching evil.
I have announced the evil before the gods,
The war of destruction against my children have I announced.
That which I brought forth, where is it. It fills the sea like fish-spawn.'
Then the Gods wept with her over the doings of the Anunnaki.
They pressed their lips together.

"Six days and six nights the wind and the deluge and the storm prevailed. At the opening of the seventh day, however, the storm lessened, the hurricane, which had waged a warfare like a mighty army, was appeased, and storm and deluge ceased. I sailed the sea mourning that the dwelling-places of mankind were changed to slime. Like logs the bodies floated around. I had opened a window, and as the light of day fell upon my face I shuddered and sat down weeping. My tears flowed over my face. Wherever I looked was a fearful sea. In all directions there was no land. Helpless the ship drifted into the region of Nizir. There a mountain in the land Nizir held the ship stranded, and did not allow it to advance farther toward the heights. On the first and second day the mountain of Nizir held the ship. Also on the third and the fourth day the mountain of Nizir held the ship. Even so on the fifth and the sixth day the mountain of Nizir held the ship. At the approach of the seventh day I loosened a dove and caused it to go forth. The dove went, it turned, and it found not a place where to rest, and it returned. I loosened and I caused to go forth a swallow. It went, it turned, and it found not a place where to rest, and it returned. I loosened and I caused to go forth a raven. The

raven flew off, and as it saw that the water had fallen it turned back. It waded in the water, but it returned not.

"Then I caused all to go forth to the four winds, and made a sacrifice. I erected an altar on the peak of the mountain. I disposed of the measured vases, seven by seven; beneath them I spread seeds—cedar and juniper. The gods smelled the odor. The gods smelled the good odor. The gods gathered like flies above the master of the sacrifice. From afar then the goddess Istar at her approach raised the great bows that Anu has made as their glory. She said, 'By the ornaments of my neck never will I forget. These days will I remember and never will I forget them forever. May the gods come to my altar. Bel shall never come to my altar, because he has not controlled himself, and because he made the deluge, and my people he has given over to destruction.'

"Bel also, at his approach, saw the vessel from afar. Bel stood still; he was full of anger against the gods and the god-like ones.

"What soul has then escaped?

"Never shall man survive the destruction.

"Adar opened his mouth and he spake. He said to the warrior Bel:

"'Who, also, if it be not Ea, can have planned this? And Ea knew and has informed him.' Ea opened his mouth and spake. He said to the warrior Bel: 'Thou herald of the gods, warrior, why hast thou not controlled thyself; why hast thou made the deluge? Visit upon the sinner his sin, upon the blasphemer his blasphemy. Be persuaded not to destroy him. Be merciful that he be not destroyed. Instead that thou shouldst make a deluge, let the lions come, and let them cut off men. Instead that thou shouldst make a deluge, let the hyenas come, and let them devour men. Instead that thou shouldst make a deluge, let the famine come and destroy the land. Instead that thou shouldst make the deluge, let the god of pestilence come and destroy the land. I have not disclosed the decision of the great gods. Hasisadra has interpreted a dream, and has understood the decision of the god.' Then Bel came to a better mind. He mounted to the interior of the vessel; he took my hand and made me to rise; myself made he to rise. He made my wife to stand up, and put her hand in mine; he turned around to us and blessed us.

"'Hitherto Hasisadra was mortal, and behold, now, Hasisadra and his wife are lifted up to the gods. He shall dwell far away at the mouths of the rivers.'

"They took me, and in a secluded place at the months of the rivers they made me abide."

Surippak, the home of the wise man, on the banks of the Euphrates, of high authority before the deluge, is the same as Sippara, where Xisuthros (= Hasisadra), according to Berosus, buried the holy writings before the flood. Its ruins have been found in the Hill of Abu-Habba, about halfway between Babylon (now Hilleh) and Bagdad.*

It was 'at the mouths of the rivers;' that is, in time of the poem, the Euphrates and the Tigris emptied separately into the Persian Gulf. Now the Schat el Arab, formed by the union of the two streams, empties into the gulf, perhaps 400 kilometers below the site of the ancient city, across a delta so low and flat that the tide runs up 300 kilometers, and at Old Nineveh the elevation is only 300 m. Delitsch † has collected the evidence that the two streams once flowed separately into the gulf. Pliny says that almost nowhere does the formation of land by a stream advance so rapidly as here. He mentions a

* Carl Schmidt, loc. cit., p. 20.

† Wo lag das Paradies.

town, Alexandria-Antiochia, which, in the third century B. C., was about 1,600 m. from the sea, and had its own harbor, and 300 years later was 33 kilometers inland. Other historical documents make it probable that the streams were separate 150 years B. C. Rawlinson says that the delta advanced 3.2 kilometers in 60 years. All the attendant circumstances accord with this location of the story. Here, among a maritime people, as connoisseurs, they ridicule the building of a ship on the land. Ea is the goddess of the sea. And it is marvellous that this trait of the original is preserved in the Koran, where the story is told at length: "And he made the ark, and as often as the elders of his people came by him they ridiculed him, and he said, 'If you rail at us, be sure that we shall also rail at you as you rail at us.'"*

From the time of Moses and the Tower of Babel, pitch or bitumen had been much used in the Euphrates valley, where the Teritary marls produced it abundantly. In Genesis xi. 3, it says of the Tower of Babel, "slime had they for mortor," and a primitive folk still pitches its boats inside and out on the waters of the Euphrates.

Thus the starting-point of the ark is well ascertained, and its landing-place can also be quite clearly located. It was in the land of Nizir, says the record. The Mesopotamian lowland is a narrow, northward extension of the Persian Gulf, between the Arabian plateau on the west and the Zagros Mountains, the scarp of the Persian highlands, on the east. An inscription of Asurnacir-pal, from the same library, reads: "Left Kalzu (by Arbela) and entered the region of the town of Babite, and approached the land Nizir." This is the account of a military expedition, and it followed up the great war road, by which, 500 years later, Darius Codomanus fled from the armies of Alexander. The region of Nizir was east of the Tigris, at the foot of the Zagros chain, 300 feet above the sea, and the craft of Hasisadra must have been swept 160 miles northeast, and stranded in the foothills on the valley border.

*Koran, XI., 40, 41.

Early accounts placed this landing on Mount Judi, in southern Armenia, where a temple in its honor was built in 776 A. D. Berosus places it in the Cordyaiean Mountains of Armenia, Genesis in Mt. Ararat (Araxes). It is remarkable how the tradition had clung to this grand volcano. The people still tell of the wood and pitch being carried from the ark as amulets, and dare not attempt to ascend the sacred mountain, and disbelieve the accounts of those few foreigners who have reached the summit. Indeed, a Constantinople newspaper account of a scientific commission sent out by the Turkish government in 1887, to study the avalanches in the mountain, tells of the finding of the ark, encased in the ice of a glacier on the mountain.

We may contrast the Chaldæan and Biblical accounts in several matters. The sending out of the birds and the bow in the heavens join with many other points to prove the identity of the stories.

In many ways the Biblical account is modified to suit the comprehension of an inland folk. While the Gilgamos epic describes a violent hurricane and inundation, which expended its force in six days, the Biblical account describes a long-continued rain of forty days, or, in the Elohistic document, of one hundred and fifty days. "And the waters were dried up from off the earth, and the face of the ground was dry." In the epic the forests were destroyed, and the face of the earth reduced to slime.

Waters rising from great rains would have swept the ship down the valley, while the epic makes it go from the gulf northeast to the region of Nizir. And, indeed, what seems the better translation of the Noachian account agrees with this. Gen.

vi. 17, "I do bring a flood of waters" is better translated "I do bring a flood from the sea," and Gen. vii. 6, "Noah was six hundred years old as the flood of waters" (or better, 'from the sea') "arose."* As Amos says, writing 'two years after the earthquake.' † "Seek him that maketh the day dark with night, that calleth forth waters of the sea, and poureth them out upon the face of the earth."‡

We may now try to strip the account of its abundant personification, and see how far it is susceptible of a possible or probable translation into scientific language.

There are, first, the warnings. Hasisatra, the wise man, and, we may assume, wise in in the ways of the sea, stands on the shore of the ancient harbor-town, Surippak, and receives the warnings of Ea, goddess of the sea. These were the unusual swellings of the sea from small premonitory earthquake shocks beneath the waters. There is next added a voice, or noise, a more unusual warning, not personified. This may have been the rumbling which may precede any severe earthquake. It is a region where earthquakes are antecedently probable. From the circle of fire that surrounds the Pacific, a zone of seismic activity connects the East and West Indies by way of the Mediterranean, and passes this region. The volcanic area of northern Mesopotamia and Syria is in seismic activity much of the time. Many towns have been several times destroyed and hundreds of thousands of people have been killed. And the recently sunken areas of 'Lemuria' to the south indicate a region of profound faulting apt for the production of earthquakes.

In the Ægean the sinking of the great land blocks by which the sea was formed is so recent that it is embalmed in the Greek mythology; Poseidon, god of the sea, ever warring victorious against the gods of the land. And, though rarely noted on the lower Euphrates, earthquakes and seaquakes, as the Germans say, are not rare across the northern parts of the Indian Ocean; the wise man accepts this warning of impending danger and builds a great craft for the safety of his home, and with the increase of the threatenings embarks his family, regardless of the ridicule of the townsfolk.

"Then arose from the foundations of the heavens a black cloud, in whose middle Ramman (the god of storms) lets his thunders roar, while Neba and Sarru rush at each other in battle. The throne-bearers stalk over mountain and plain." These latter are the great slow-moving sand columns (whirlwinds) which precede and hang on the borders of the coming storm. They still occur around Bagdad, change day into night, and extend over the whole valley of the Euphrates. "The mighty god of pestilence lets loose his hurricanes." So far it is the description of the oncoming of a mighty storm. Then follow elements which may be interpreted as earthquake phenomena. The Biblical account says the foundations of the great deep were broken up, and at the end they were stopped. This may be explained as the uprush of the ground waters, so marked at Charleston and New Madrid, on the Indus plain, at Lake Baikal, where a lake ten by fifteen miles was formed, and in the delta of the river Selenga, when the fastenings of the wells were blown into the air like the corks of bottles. "The Annuniki raise their torches; they make the land glow with their radiant gleams." The Annuniki are the gods of the underground, the gnomes or kobolds of German saga, and their raising their torches is the inflaming of the natural gases, so common in these bituminous Tertiary beds, in the fissures opened by the

* J. D. Michaelis (Bunsen); majim = water, mijam = from the sea.

† Amos, i., 1.

‡ Amos, v., 8.

earthquake—a frequent occurrence also in similar regions on the Caspian.

In the earlier translation by Haupt the suggestions of earthquake intervention were even more striking than in the later translations. "Adar lets the canals overflow unceasingly. The Annuniki bring floods from the depths. They make the earth tremble by their might." Although hurricane inundations have overwhelmed great areas of land, the earthquake wave is in many ways a mere probable agency here for the production of a flood, exceptional as this must have been to have impressed itself so deeply on this ancient folk. We recall the Lisbon earthquake wave; how the United States warship Monongahela was carried ashore in 1863, at Santa Cruz, and landed on the tops of the houses; or how the great seismic wave of 1868 carried the Wateree in the harbor of Arica, Peru, seven or eight miles inland, landing her in a tropical forest, where she ended her days as a hotel, while her consort, the Fredonia, rolled over and over, and sank with all on board; or the last terrible earthquake waves in Japan and China.

The account then advances strongly to its climax and catastrophe. "Ramman's flood-wave mounts up to heaven." All light sinks in darkness. Terror overcomes gods and men. "Like dogs in their lair the gods crouch at the windows of heaven." This is the description of the incoming of the great cyclonic waves, perhaps reinforced by earthquake waves, for when the seismic tension has just come to equal the resistance the great additional strain caused by the relief of pressure of the low barometer of the cyclone has not infrequently set loose the impending earthquake. Of 64 hurricanes in the Antilles 7 were accompanied by earthquakes. In the Bay of Bengal the cyclones average one a year and destroy a million people in a century; and once at Calcutta, in 1737, when the waters rose 40 feet, 14 ships were carried over the trees and 300,000 people were killed; and on the Kistna in 1800 the cyclone and the earthquake occurred together. Indeed, several of these cyclones have been traced across into the Persian Gulf, and one in 1769 was accompanied by an earthquake on the lower Euphrates—the very site of the ancient myth. On the broad plains of the Punjaub are many indications of similar inundations. I travelled, said Ibn Batuta (1333), through Sind to the town Sahari, on the coast of the Indian Sea, where the Indus joins it. A few miles from here are the ruins of another town, in which stones in the form of men and animals in almost innumerable amount occur. The people were so sinful that God changed them to stone and their animals and their grain. It is interesting to observe the different effects these disturbing events have upon people of different grades of culture.

The Negritos of the Andaman Islands have a demon of the land who causes the earthquakes, a demon of the sea who causes the floods.

The King of Dahomey in 1862 had received the missionaries in the land. The spirit of his fathers shakes the earth because old observances were not followed. The King executes three captive chiefs as an envoy to inform his fathers that the ancient rites shall be re-established.

After the great earthquake of Kioto and Osaka in Japan, in 1596, the warrior Hidiyoshi goes to the temple of Daibutzu (the Buddha), where the enormous bronze statue had been overthrown, and upbraids the fallen idol and shoots it with arrows.

In 62 A. D. Oppolonius of Tyana, at Phæstus, in Crete, was preaching to a company of worshippers of the local deity, when an earthquake arose. "Peace," he said, "the sea has brought forth a new land." An island was found between Thera and Crete, Santorin, beloved of all geologists in modern

times. The crowd loses all judgment in wonder and admiration.

A true flood panic occurred in the time of Charlemagne. Stöffler, a celebrated astronomer and professor of mathematics at Tübingen, found, as the result of abstruse calculation, that the earth would be destroyed by a flood in 1524. The news spread rapidly and filled Europe with alarm. In Toulouse an ark was built by advice of the professor of canonical law to rescue at least a part of the people. Indeed, in our own days, Prof. Rudolph Falb and similar prophets announce a new flood in the year A. D, 7132.* And Falb has by his unverified earthquake predictions caused panics in Athens and Valparaiso.

It is the western migration of this ancient story that is noteworthy, and its association with the punishment of sin by the religious genius of the Hebrews which has made it world-wide. Such myths of observation, dependent on local floods or the suggestion of fossils, are most widely spread, and they find place in cosmogonic myths—explanations of the origin of land and sea; national myths—explanations of the origin of peoples; and myths of destruction of land or people, with or without the idea of punishment for sin.

They are wanting among the Africans and in Australia and Oceania according to Lenormant; more accurately among the Papuans of Oceania, for the Feejee Islanders kept great canoes on the hill-tops for refuge when the flood should return.

In China the great Cyclopedia (2357 B. C.) says: "The waters of the flood are destructive in their inundation. In their wide extent they surround the mountains, overtop the hills, threaten the heaven with their waters, so that the common folk is dissatisfied and complains. Where is the able man who will undertake to control the evil. Kwan tries nine years, Yu eight

*Schmidt, loc. cit., p. 61.

years. He completes great works, cuts away woods, controls the streams, dykes them and opens out their mouths. He feeds the people."

This refers to the 'Curse of China,' the Yang-ze-Kiang, which flows sometimes into the Gulf of Pechili north of the promontory of Shantung, sometimes to the south of the Yellow Sea.

Our own Indians gave Catlin 160 flood myths. The dog of the Cherokees is well known. On Cundinamarca in Mexico there were four destructions: of famine, personified by giants; of fire, by birds; of wind, by monkeys; of water, by fishes.

The Quichés of Guatemala say: As the gods had created animals who do not speak or worship the gods and had made men from clay who could not turn their heads—who could speak indeed, but not understand anything—they destroyed their imperfect work by a flood.

A second race of mankind was created, the male of wood, the woman of resin, but it was not thankful to the gods. The gods rained burning pitch on the earth, and sent an earthquake, destroying all but a few, who became monkeys. A third attempt succeeded so well that the gods themselves were terrified at the perfection of their work, and took from them some of their good qualities, and the normal man resulted.*

The Arawaks of British Guiana and Venezuela were for their sins twice destroyed—once by flood, and once by fire, and only the good and wise were saved.

The flood is a perennial blessing in Egypt, and when the Greeks told the priests of the deluge of Deucalion they said, 'Egypt has been spared this.'

There is an inscription on the walls of the tomb of Seti-on, in Thebes, 1350 B. C. The sun-god, Ra, is wroth with mankind, and the council of the gods decree its doom. Hathor, queen of the gods, does the work,

*Schmidt, 'Sintflut,' 57.

till all the land is flooded with blood. She sees the fields flooded with blood, she drinks thereof; her soul is glad; she does not know mankind. Only those who, at the right time, fix their thoughts above are spared, and of these the Majesty of Ra says: 'These are the good.'

In Persia there are no flood myths preserved before time of Zoroaster.

In India, where the flood is a constant scourge, the four Yugas (ages) and the four Manvartaras, the alternate destructions and renewals of the human race, are Vedic myths, and no trace of the flood story appears in the Vedas. The Satapatha-Bramahna, written just before the time of Christ, is especially interesting, from the blending of the Chaldean account with the Indian mythology. In this oldest account the flood came from the sea, the warning and the rescue of Manu, the Indian Noah, from Vishnu, in form of a fish. Here all the suggestion may be indigenous. There is no punishment.

In the Mahabharata the ship lands on the highest peak of the Himalaya. In the last part of the story, in the Bhagarata Purana, the motive of the flood is that the wickedness of man was great in the earth. Vishnu, in the form of a fish, warns Manu Satjavrata, the well-doer (Ea was a fish-god in the Chaldæan story, and Oannu, in Berosus, was a fish-god), that in seven days the three worlds will sink in an ocean of death, but in the midst of the waves a ship will be provided for Manu. He is to bring all useful plants and a pair of all irrational animals into the ship. The sea rose over its banks and overwhelmed the earth. Violent wind and cloudburst from measureless clouds contributed to the flood. Vishnu, in form of a gold-gleaming fish, guided the ship. Before the flood the holy Vedas were stolen, afterwards they were restored by Vishnu.

In Greece, also, as the sinking of the land has persisted to greater extent into the most modern times, so the flood-myths have there greater variety and definiteness than elsewhere, and later the Chaldæan account was grafted on to the earlier with greater fulness. The story is not known to Hesiod in the 'Works and Days' (8th century B. C.), though he enumerates several destructions of the sinful race of man, and the 'Iliad' mentions destructive cloudbursts as the usual punishment of heaven on the unjust judge.

Thus, in the Bœotian myth Ogyges, it is significant that Ogyges was son of Poseidon, god of the sea, and I have heard the name itself derived from an Aryan root, meaning a flood. Ogyges is rescued in a boat.

The story of Deucalion's flood is first given in the Hesiodic catalogues, 800 to 600 B. C. Pyrrha and Deucalion were alone rescued in a ship. As told in an archaic form by Pindar* (500 B. C.), 'Pyrrha and Deucalion, coming down together from Parnassus, founded their mansion first, and, without marriage union, produced the strong race of the same stock, and hence they were called Laioi from a word meaning stones, as they threw stones over their heads to form the first men.

Apollodorus (100 B. C.) shows the first influence of the Semitic myth. He extends the flood over almost all Greece, and says Deucalion offered sacrifice on leaving the ship. Later, the ark, the taking-in of animals and sending-out of birds, appear in the Greek myth, and Lucian, or pseudo-Lucian, in "De Dea Syria" (160 A. D.), in a chapter on Hydrophoria, narrates an Armenian flood-myth, which had its home in the upper Euphrates, at Hierapolis, the modern Mambedj, and blends the Hellenic and Semitic story. "The most say that Deucalion Sysythes built the sanctuary, that Deucalion under whom the great deluge occurred. Of Deucalion I heard also in Hellas the story which the Hellenes

*Olympics, IX., 4 (500 B. C.)

tell of him, which runs as follows: The first men had grown very wicked upon the earth, and, in punishment, suffered a great evil. The earth sent up from its bosom mighty masses of water. Heavy rains followed, the rivers swelled, and the sea overflowed the land, until all was covered with water, and all were destroyed; only Deucalion, of all mankind, remained alive. He had built a box or ark, and his family, as also pairs of all kinds of animals, entered into it. All sailed in the ark as long as the waters continued. So the Hellenes write of Deucalion. To this the inhabitants of the holy town add a very strange story; that in their land a great fissure opened in the earth, and this received all the water. Deucalion built altars after this happened, and by the opening built a temple to Here. I saw the opening. It is under the temple, and is very small. As a sign and remembrance of this story, they do as follows: Twice a year water is brought to the temple from the sea. Not alone do the priests bring this; out of all Syria and Arabia, India, and from beyond the Euphrates many go down to the sea, and all bring water. They pour it out in the temple, and it flows into the fissure, and the small opening receives a great quantity of water. And this ceremony, they say, Deucalion appointed in the temple in remembrance of the catastrophe and his rescue. A statue of Here is in the temple, and another god, which, although it is Zeus, they call by another name. Between the two stands a golden column. The Assyrians call it the sign, give it no special name, and cannot explain its origin or its form. Some refer it to Dyonysus, others to Deucalion, others to Semiramis. There is on its top a golden dove. Therefore, it is said to represent Semiramis. Twice a year it is taken to the sea to bring water, as described above." There were similar Hydrophoria at Athens.

AMHERST COLLEGE. B. K. EMERSON.

SECTION A—MATHEMATICS AND ASTRONOMY.

THE Vice-Presidential address before Section A was necessarily omitted, as illness in his family had prevented Prof. Story from preparing an address and from attending the meeting.

The vacancy in the chair was filled by the election, by the Association, of Prof. Alexander Macfarlane as Vice-President for the Section.

The following papers were presented before the Section, in number one less than were read at the Springfield meeting last year.

An Analog to De Moivre's Theorem in a Plane Point System: By E. W. HYDE.

Three points, e_0, e_1, e_2, at the vertices of an equilateral triangle, are taken as a reference system, and an operator ω is assumed such that

$$\omega e_0 = e_1,\ \omega^2 e_0 = \omega e_1 = e_2,\ \omega^3 e_3 = \omega^2 e_1 = \omega e_2 = e_0.$$

Then the action of the general operator

$$x_0 + x_1\omega + x_2\omega^2,$$

in which $x_0 \ldots\ldots x_2$ are scalars, is discussed. The x's are shown to be functions of a scalar n and an angle θ, designated as $K(n, \theta)$, such that

$$[K_0(n, \theta) + \omega K_1(n, \theta) + \omega^2 K_2(n, \theta)]^k$$
$$= K_0(n^k, k\theta) + \omega K_1(n^k, k\theta) + \omega^2 K_2(n^k, k\theta),$$

which is the analog of De Moivre's theorem. Addition-multiplication theorems for the K-functions are found, and a trigonometry of them developed.

Rational Scalene Triangles: By ARTEMUS MARTIN; read by the Secretary.

In this paper, which will appear in the *Mathematical Magazine*, formulæ are given for calculating the sides of rational triangles, with numerous illustrative examples.

New elements of the variable R Comæ, resulting from observation in July and August, 1896, and

Photometric Observations of Colored Stars: By HENRY M. PARKHURST.

The large discrepancies in photometric measures of colored stars led the author, who employs the method of extinctions in his photometer, to investigate the absorption of three principal colors—red, yellow and blue—by differently colored shades. The relative proportions of the three colors in the light of any particular star were measured, and corrections were deduced so that the effect of color was very largely overcome in observations by the method of extinctions.

Motion of the Great Red Spot and Equatorial Belt of the planet Jupiter from 1879 to 1896: By G. W. HOUGH.

From the comparison of his micrometrical measures (not mere drawings) of definite points upon the visible disk of the planet, the author obtained the (changeable) rate of rotation of the spot about the planet's rotation-axis, and he showed charts and diagrams of the motions of the belt both in latitude and longitude. No theory of the nature of the spot was advanced. The paper will be printed in the *Monthly Notices* of the Royal Astronomical Society.

On the direct application of a rational differential equation to a series of points whose coordinates represent observed physical properties: By ROBERT B. WARDER.

The theory for the speed of chemical action gives rise to differential equations, which are usually integrated before being applied to test a series of measurements. As the theoretical 'constant' often proves to be variable (showing that the assumed rational formula does not fully represent the processes of Nature), the character of the variations must be determined by one of several modes of calculation. The paper was mainly an inquiry as to the best methods of computing the required quantities. Three methods had been tried in an application to Lichty's determination of the speed of esterification of monochloracetic acid, and a further paper (offered with this for publication in the *Journal of Physical Chemistry*) was read before Section C.

A proposed fundamental integral-transcendent: By JAMES McMAHON.

A large number of transcendent integrals are reducible to the fundamental form

$$\int \log \sec x \, dx.$$

which may be computed from a series and tabulated for different values of x. Let the function *ils* x (integral-log-secant x) be defined by the equation

$$\int_0^x \log \sec x \, dx = \text{ils}\, x,$$

then ils x may be computed and tabulated from the development

$$\frac{2}{\pi} \text{ils} \frac{\pi x}{2} = S_2 \frac{x^3}{3} + \frac{S_4}{2}\frac{x^5}{5} + \frac{S_6}{3}\frac{x^7}{7} + \frac{S_8}{4}\frac{x^9}{9} \ldots\ldots$$

$$\left(\text{where } S^n = \frac{1}{1^n} + \frac{1}{3^n} + \frac{1}{5^n} \ldots\ldots \textit{ad inf.}\right)$$

which is convergent when $x < 1$, and can be used when the argument $\frac{\pi x}{2}$ lies between 0 and $\frac{\pi}{2}$,—a sufficient range, since ils $\frac{\pi}{2} = \infty$ and ils $0 = 0$.

Numerous integrals were given which are expressible in terms of ils x, of which we illustrate by only three:

$$(1) \int_0^x \log \cos x \, dx = - \text{ils}\, x.$$

$$(3) \int_{\frac{\pi}{4}}^x \log \tan x \, dx = \text{ils}\left(\frac{\pi}{2} - x\right) + \text{ils}\, x - 2\, \text{ils} \frac{\pi}{4}.$$

(This may be denoted by *ilt* x, integral-log-tan x.)

$$(11) \int_1^x \frac{\log x}{1+x^2} dx = \text{ilt}\,(\tan^{-1} y), \text{ etc.}$$

Analogous relations are found for hyperbolic functions. The paper will appear in the *Annals of Mathematics*.

On the Level of the Sun-Spots: By EDWIN B. FROST.

The correctness of the Wilsonian doctrine that Sun-spots are depressions in the solar

photosphere is examined, and evidence is brought forward from recent direct visual observations (Howlett, Sidgreaves, Spoerer), from the rate of solar rotation deduced from faculæ, spots, and surface (Dunér), and from the thermal absorption over spots, to support the view that spots may be masses of absorbing gases above rather than below the photosphere. The paper will be published in the *Astrophysical Journal*.

Sedenions: By JAMES B. SHAW; presented in outline by Prof. E. W. Hyde.

If q be any quaternion, Φ the operator on q such that if

$$\begin{aligned} q &= w + xi + yj + zk, \\ \Phi\, q &= (a^{\mathrm{i}}w + b^{\mathrm{i}}x + c^{\mathrm{i}}y + d^{\mathrm{i}}z) \\ &+ (a^{\mathrm{ii}}w + b^{\mathrm{ii}}x + c^{\mathrm{ii}}y + d^{\mathrm{ii}}z)i \\ &+ (a^{\mathrm{iii}}w + b^{\mathrm{iii}}x + c^{\mathrm{iii}}y + d^{\mathrm{iii}}z)\, j \\ &+ (a^{\mathrm{iv}}w + b^{\mathrm{iv}}x + c^{\mathrm{iv}}y + d^{\mathrm{iv}}z)\, k. \end{aligned}$$

Φ is called a *Sedenion*. The paper (offered for publication in the *Bulletin of the American Mathematical Society*) is a development of the elementary formulæ of *Sedenions* considered as an algebra of sixteen units. These formulæ are developed by the aid of Quaternions.

On the Distribution and the Secular Variation of Terrestrial Magnetism, No. IV: On the Component Fields of the Earth's Magnetism: By L. A. BAUER.

This paper, to appear in *Terrestrial Magnetism*, continues the researches hitherto published by the author, and is an attempt to resolve the prevailing magnetic field of the earth into its components. The paper was illustrated by maps and diagrams.

Determination of the Weights of Observations: By J. R. EASTMAN.

A brief account was given of a method of determining the weights to be used in combining the results of observations made in a series of years with the same instrument (meridian circle). The results also showed the futility of excessive repetition of an observation with a view to increased accuracy.

On the Composition of Simultaneous and Successive Vectors: By ALEXANDER MACFARLANE.

Vector Algebra is commonly founded partly on physical ideas, partly on arbitrary formal laws. The author prefers to give it a purely geometrical or physical basis. The sum of simultaneous vectors is commutative, because they have no real order; the sum of successive vectors is not commutative, because they have a real order. The square of a sum of successive vectors differs from the square of a sum of simultaneous vectors by a set of terms depending on the order of the succession. This was illustrated by the generalized form of the Exponential Theorem for space.

All the papers on the program having been read, at the conclusion of the session on Wednesday afternoon, August 26th, Section A adjourned.

EDWIN B. FROST,
DARTMOUTH COLLEGE. *Secretary.*

SECTION B—PHYSICS.

THE address of the Vice-President, Carl Leo Mees, upon *Electrolysis and some Outstanding Problems in Molecular Dynamics*, will be printed in this JOURNAL.

The meetings of the section were full and interesting. One of the sessions was interrupted by the introduction of Dr. Chas. E. West, of Brooklyn, a founder of the Association, who gave reminiscences of Joseph Henry and exhibited a small helix made by Prof. Henry and used by him in conjunction with Dr. West on July 10, 1842, to magnetize needles during a thunder storm. Dr. West also exhibited a fragment of wood from the ship of Captain Cook, given him by the elder Silliman sixty years ago. The remarks of Dr. West were listened to with profound interest and the section tendered to him a vote of thanks.

The section enjoyed a visit to the home of Mr. Edgar B. Stevens, a manufacturer

of Buffalo, who has a large collection of Crookes' tubes with accessory apparatus for the exhibition of the Röntgen rays.

On Friday afternoon the section made a special excursion to Niagara Falls, and the members were courteously received at the large Power House, at the Carborundum Factory and at other places of interest.

During the seven working sessions of the section twenty-nine papers were read in full and two by title.

Polarization and Internal Resistance of a Galvanic Cell: By B. E. MOORE.

The E. M. F. between each electrode of a cell of the Leclanché type, without depolarizer, and an auxiliary carbon electrode was determined during the polarization of the cell and during its subsequent recovery.

The Lead Storage Cell: By B. E. MOORE.

The author explained from Nerst's theory the character of the curves of charge and discharge of a lead storage cell.

A Theory of Galvanic Polarization: By W. S. FRANKLIN and L. B. SPINNEY.

The authors pointed out the existence of a term in the energy equation of the electrolytic cell depending upon an irreversible or sweeping process at each electrode. Experiments were described showing that the coefficients of these terms do not in general vanish with the current.

On the Counter Electromotive Force of the Electric Arc: By W. S. FRANKLIN.

The author attempted the experimental determination of the decay of E. M. F. between the carbons of the electric arc after the circuit is broken. It was pointed out by G. W. Patterson that the results were entirely ambiguous.

On the Element of Diffraction in Fresnel's Experiments with two Mirrors and with the Biprism: By ERNEST R. VON NARDROFF.

The author discussed in detail the coloring by diffraction of the central band obtained by Fresnel's mirrors and Fresnel's bi-prism.

Segmental Vibrations in Aluminum Violins: By ALFRED SPRINGER.

Five years ago the author pointed out that the acoustical properties of aluminum are approximate to those of wood. Continued experiments made with aluminum sound boards have verified this earlier conclusion. The author exhibited several aluminum violins, together with a device, called a bass bar, by means of which the quality of the tone produced by the instrument can be controlled.

Preliminary Note on a proposed new Standard of Light: By CLAYTON A. SHARP.

It is proposed to define a standard of light as a flame of definite size produced by a gas of definite composition burning in a continuously renewed atmosphere of definite composition. Experiments have been made with a mixture of equal parts of acetylene and hydrogen burning in an atmosphere of pure oxygen. The mixture of acetylene and hydrogen issues from a small tube, surrounding which is a larger tube supplying oxygen. The importance of using dry gases was pointed out.

A Photographic Study of the Röntgen Rays: By W. A. ROGERS.

Note on the Duration of the X-Ray Discharge in Crookes' Tubes: By BENJAMIN F. THOMAS.

It has been found that slow make and break in the primary of an induction coil produces almost as strong effect on a Crookes' tube as very rapid make and break. This seems to indicate the long duration of activity of the tube at each discharge. The author has shown, however, that the duration of the acting discharge is as short as $\frac{1}{5000}$ second and probably as short as $\frac{1}{50000}$ second.

Preliminary Communication concerning the Anomalous Dispersion of Quartz for Infra-

red Rays of Great Wave-length: By ERNEST F. NICHOLS.

In the absence of the author this paper was presented in abstract by Prof. E. L. Nichols. The author has investigated the optical (?) properties of quartz for waves greater than 4 μ.

The reflection from a surface cut perpendicular to the optic axis was found to decrease steadily from $3\frac{1}{2}$ % at wave-length, 4.5 μ to a minimum of 0.29 % at 7.4 μ. From this point the reflection increases rapidly to 14 % at 8 μ, 36 % at 8.1 μ, reaching a maximum of 76 % at 8.4 μ. A second minimum of 51 % was found at 8.6 μ and a second maximum of 65 % at 8.8 μ; beyond which the reflection falls to 50 % at 9 μ.

The transmission through a quartz plate 18 μ in thickness cut perpendicular to the optic axis shows three pronounced minimum and four maximum values between 4 μ and 7 μ. The last maximum is at 7 μ. The transmission at this point is 80 % From this point the transmission falls to 51 % at 7.6 μ, 36 % at 7.7 μ, 12 % at 7.9 μ and to a value less than 1% at 8.1 μ. Beyond 8.1 μ the transmission is imperceptible.

A computation of the indices of refraction from observed reflection and transmissions by the Cauchy formula has given results which agree with the Ketteler-Helmholtz dispersion formula, which, according to Rubens' constants, requires rays in the region of 8 μ to be bent towards the apex rather than towards the base of a quartz prism.

The reflection and transmission measurements were made with a Torsion Radiometer. The radiations pass through a fluorite window into a vacuum chamber and fall upon a blackened vane of mica, 2x15 mm., which is carried by a light arm at a distance of 2 mm. to one side of a quartz fibre. The deflection of the vane is observed by means of a mirror, telescope and scale. The sensitiveness of the instrument, with a full vibration period of 12 seconds, was such that the rays from a candle at a distance of six meters gave a deflection of 61 divisions on a scale distant 1 meter from the instrument. When properly protected the instrument is absolutely without 'drift,' and the zero point remains constant within a centimeter for days at a time.

An Experimental Study of the Charging and Discharging of Condensers: By F. E. MILLIS.

In the absence of the author this paper was presented by Ernest Merritt, who exhibited a number of very fine photographic tracings of alternate current curves and of curves obtained by the charge and discharge of condensers. The instrument used was essentially a tangent galvanometer with a miscroscopic soft iron magnet and mirror placed in an intense magnetic field and having about 17,000 free half-vibrations per second.

Notes on certain Physical Difficulties in the Construction of Modern Large Guns: By W. LECONTE STEVENS.

The author related some experiences in connection with the manufacture of a large gun at the Watervliet arsenal, on the Hudson river.

On the Photographic Trace of the Curves described by the Gyroscopic Pendulum: By ERNEST MERRITT.

The author exhibited a number of the curves.

On the Distribution of High Frequency Alternating Currents throughout the Cross-Section of a Wire: By ERNEST MERRITT.

The author exhibited, by platted curves, the results of extensive calculations from the formulæ of Lord Kelvin and Heaviside.

On the Compactness of a Beam of Light: By ERNEST R. VON NARDROFF.

The author calls the solid angle subtended by the extreme rays of a beam of light at a

point the *vergency* of the beam. Assuming the luminous source to be of uniform brightness, he shows that the quotient—intensity of beam divided by vergency—is a constant; this he calls the compactness of the beam. He applies this conception to the discussion of various theorems in connection with optical instruments.

Some Points in the Mechanical Conception of the Electro-magnetic Field: By W. S. FRANKLIN.

The author pointed out the importance of applying the conceptions of Maxwell and Lodge directly to the explanation of fundamental principles instead of to special cases. In addition to the explanation of the two laws of induction he applied the conceptions of Maxwell to the explanation of the energy stream and to the explanation of electro-magnetic waves.

Mechanical Models of the Circuit: By BROWN AYRES.

The author exhibited a model consisting of a number of fly-wheels arranged in a circuit with spring connections. The model represented in a striking manner nearly all of the fundamental phenomena of the electric circuit, particularly the phenomena of electrical oscillation and resonance.

Graphical Treatment of Alternating Currents in Branching Circuits: By HENRY T. EDDY.

The author gave an elegant treatment of the general problem of branched circuits containing resistance, inductance and capacity, showing the construction of the locus of the resultant current vector for varying frequency.

Description and Exhibition of a Convenient Form of the 'Interferential Comparer,' and of an Interferential Caliper Attachment for Use in Physical Laboratories: By W. A. ROGERS.

Description and Exhibition of a Bench Comparator for General Use in Physical Laboratories: By W. A. ROGERS.

On the Rule for the Dynamo and Motor: By ALEXANDER MACFARLANE.

In the discussion of this paper Prof. S. T. Moreland gave a mnemonic rule, not generally known, associating the directions of the electric current and of the magnetic field with the hand in such a way that the force is in the direction one would naturally push.

Note on the Effect of Odd Harmonics upon the Virtual Values of periodically varying Quantities: By FREDERICK BEDELL and JAMES E. BOYD.

The authors showed that the virtual value of a periodic E. M. F. is independent of the phase relations of its odd harmonics, but dependent only upon their amplitudes.

Experimental Determination of the Relative Amounts of Work Done in changing the Lengths of two metal Bars under the same Thermal Conditions, by an Envelope of Heated Air, and by Pure Radiations in a Vacuum: By W. A. ROGERS.

The author explained the difference in the behavior of a metal bar in an air bath and in a vacuum.

An Experimental Method of Finding the Value of a Unit of Force in Any System Whatever: By W. A. ROGERS.

A new Alternating Current Curve-tracer: By EDWARD B. ROSA.

The author described an apparatus by means of which the successive points in an alternate current or E. M. F. curve are platted directly, avoiding the necessity of taking and entering numerical observations. He exhibited a large number of curves, originals and enlargements.

Visible Electric Waves: By B. E. MOORE.

The author described an arrangement in which stationary electric waves on a wire are rendered visible by the brush discharge from the various portions of the wire.

Electrical Waves in Long Parallel Wires: By A. D. COLE.

The author described some preliminary work carried out in connection with the determination of the dielectric constants of liquids.

The Influence of a Static Charge of Electricity on the Surface Tension of Water: By Edward L. Nichols and John Anson Clark.

The authors used a dropping apparatus for determining the surface tension, and a novel electrometer for measuring E. M. F. This electrometer consisted of a light conducting sphere suspended by a long conducting fibre near a large plane plate. The movement of the sphere was observed by means of a telescope.

Determination of the Specific Heats of Nitrogen by Adiabatic Expansion: By W. S. Franklin and L. B. Spinney.

The authors pointed out the fact that of the four quantities R (in the equation $pv = Rt$), K, C_p and C_v associated with a gas only two are independent; and they described some incomplete experiments for the indirect determination of C_v.

The Analysis of Vowel-sounds, by Means of the Sympathetic Vibrations of a Rigid Body: By L. B. Spinney.

The author described the manner of mounting a light mirror so as to vibrate with sound waves impinging upon it, and exhibited a number of photographic tracings.

Polar and Interpolar Effects of the Galvanic Current on Living Animal Tissues: By C. P. Hart.

Description and Exhibition of a Portable Apparatus for Recording Curves of Alternating Currents and Electro-motive force: By H. J. Hotchkiss.

The author exhibited the apparatus, and also, some photographic tracings taken by means of it.

The discussion of Nomenclature and Units was made a special order for the last Sectional meeting, but on account of lack of time it was deferred and made a special order for the meeting of next year.

Iowa State College. W. S. Franklin.

THE PHYSIOLOGY OF COLOR IN PLANTS.

Since the preparation of my recent summary of the uses of color in plants* the work of Stahl in the botanic garden at Buitenzorg has been published,† by which some of the current conclusions are seriously modified.

I have pointed out in the paper cited above that the theories concerning the relations of plant colors to animals are by no means on a secure basis, and Stahl by a large number of experiments in which red and green leaves were fed to snails, rabbits, antelopes, etc., finds that the choice of food depends on the degree of hunger of the animal to a much greater extent than on the color of the plants eaten. He concludes that in no instance is it placed beyond doubt that color areas have been developed as a 'warning' to serve as a protection against animals, but is disposed to regard the so-called warning devices as accidental.

Because of the prevailing acid reaction of red leaves, this author uses the term 'Erythrophyll' to denote the reddish coloring matter, instead of 'Anthocyan.' So far as its physical qualities are concerned, he confirms the view of Engelmann that its spectrum is complementary to that of chlorophyll. He does not, therefore, agree with the theory of Kerner that color layers may serve as a protection of the chlorophyll against intense sunlight,‡ but formulates an extended and modified statement of Pick's conclusions, § in which he sug-

* MacDougal: Physiology of Color in Plants. Pop. Sci. Monthly, May, 1896.

† Ueber bunte Laubblätter. Ann. d. Jard. Bot. Buitenzorg, 13: 137–216. 1896.

‡ Pflanzenleben, 1: 364. 1890.

§ Bot. Centralblatt, 16: 1883.

gests that the color layers act as a screen for the conversion of light into heat, useful not only in the trans-location of the carbohydrates, but also in all metabolic processes. Such a use is subserved in alpine plants; in those of eastern North America, in which the climatic conditions are alpine; in the pistils of anemophilous plants, to promote the growth of pollen tubes; in extra floral nectaries, to accelerate the metabolism of the carbohydrates, and in many adaptations in the Cryptogams.

Reasoning from the fact that a large number of plants growing in shady moist situations, and in the tropics where the air is much warmer than the leaves, are provided with erythrophyll, absent from specimens under the opposite conditions, he substantiates and extends the idea of Kerner that the color in these instances is a device for promoting transpiration.

Further, the colors of young shoots and leaves act in the same manner, and, by increasing the amount of water conducted to these parts, secure a greater supply of nutritive salts.

It is but proper to say, however, that this method of reasoning does not explain in any adequate manner the autumnal colors, nor of course the occurrence of colors in external hairs, or in the internal tissues, where no relation, or no useful relation, to light can exist.

By far the most interesting portion of the paper is that in which the results of the investigation upon the whitish or silvery patches due to air cavities underneath the epidermis of leaves of Begonia, Dracæna, etc. It was found that if the under side of such leaves were coated with some substance easily melted, such as cocoa butter, and the upper side exposed to light or heat, the portions of the leaf under the silvery areas were less easily heated, and consequently less easily cooled, than the neighboring green areas.

This device retards chlorophyll action, but under the cool, damp conditions in which such plants are found it promotes transpiration by preserving a temperature higher than the surrounding atmosphere.

The velvety appearance of many leaves is found to be due to the papillose extension of the epidermal cells in such form as to act as lenses in entrapping rays of light or heat striking the surface at any angle, thus securing an additional aid to transpiration.

The chief results of the paper may be summarized as follows: The existence of 'warning' colors is not proven; the conclusion of Pick that leaf-red converts light into heat, useful in translocation of carbohydrates, is broadened to include the general metabolism of the plant in its application; the 'protection' theory of leaf-red by Kerner is refuted in great part; the conclusions of Kerner as to the uses of leaf-red as a means of promotion of transpiration are extended and substantiated; and the silvery white as well as the 'velvety' appearance of many leaves are to be regarded as means for the promotion of transpiration under different circumstances.

D. T. MACDOUGAL.

MINNEAPOLIS, MINN.

CURRENT NOTES ON ANTHROPOLOGY.

MORTUARY CEREMONIES.

PROPERLY studied, the mortuary ceremonies of tribes offer one of the most productive fields of ethnologic research. A valuable contribution to this branch has lately appeared in Dr. W. Caland's *Die Altindischen Todten- und Bestattungsgebräuche* (pp. 191, J. Müller, Amsterdam, 1896). Its investigations are based on a close collation of the rituals for the dead in the various Vedas and other sources, a number of them still in manuscript. The earlier researches of Colebrooke, Wilson, Max Müller and others have been considered, and extensive additions to their studies are

offered. All the steps of the ceremony of incineration are examined in the original texts, followed by those referring to the gathering of the bones, the erection of the funerary monument, the offerings to fire, the strewing of the seed, and the numerous steps of the complicated ritual. These the author handles with a thorough mastery of the subject and the language. When it is remembered that to an ancient Aryan (and to many non-Aryans) no object in his life was so important as that he should have proper funeral rites, the interest attached to such ceremonies will be appreciated.

M. Felix Regnault, in the Bulletins de la Société d' Anthropologie of Paris (Fasc. 1, 1896), in an article on funeral rites, argues that incineration and various other methods of destroying the flesh were intended for the benefit of the living, not to follow out the wishes of the dead. The survivors wanted the bones for charms and fetishes.

THE PSYCHOLOGY OF PRIMITIVE MAN.

WHAT is the mental state of savages, and, going beyond them, what were the mental powers of early man, are queries of prime interest in ethnology. Some have placed the hunting tribes on a par with immature individuals in civilized lands; while others hold 'the gray barbarian lower than the Christian child.' This is the opinion of Dr. Friedmann, who, in a paper analyzed in the *Centralblatt für Anthropologie*, Heft 3, undertakes to prove that the state of primitive thought is nothing more nor less than insanity, and has its parallel only in our asylums for mental diseases. He claims that to the savage, as to the insane, there is no distinction between the idea and its reality, that the law of causality is restricted to the narrowest sensuous limits, and that the logical processes of thought are constantly violated. All this is true, but do we dare or care to say how true it is also of the people at large around us?

The same subject has been treated at length by Prof. Pinsero, of Palermo, whose views are epitomized in *L'Anthropologie*. He thinks that early man was mentally lower than the anthropoid apes, for these had a religion, to wit, serpent worship (!) and man had none.

No doubt the estimate of the savage mind has been placed too high by various writers; but this looks as if the current is just now as much too strong in the other direction.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

SCIENTIFIC RESEARCH AND COMMERCIAL SUCCESS.

A LETTER from Prof. W. Ostwald on scientific education in Germany and England has been communicated by Prof. W. Ramsay to the London *Times* and is made the occasion of 'leaders' in that journal and in *Nature*. Germany has, as is well known, supplanted Great Britain in the control of the fine chemical markets of the world, and this is due more to scientific research than to commercial enterprise. Prof. Ostwald informs us that there are many chemical works in Germany, each of which employ more than one hundred students of chemistry who have taken their Doctor's degrees at the University, and are engaged not in the management of the manufacture, but in making inventions. These chemists have been trained for years under men such as Prof. Ostwald; they have published theses containing the results of original research, and finally are able to devote their lives to invention and investigation. Those who cannot appreciate the scientific importance of research will be convinced by the logic of commercial success.

If a very small part of the money spent by the government of the United States in the protection of manufactures by import duties had been used in higher technical education, and especially in the encouragement of scientific research, we feel sure that the industries and commerce of the country would be in a very different condition from that in which they are

now found. They would not need to ask protection from foreign competition, but would dictate terms to every nation. Both in Great Britain and the United States enormous sums of money are annually spent, and well spent, in primary and secondary education. Yet this education is chiefly of advantage to the individual, whereas higher education and research, chiefly of advantage to the State, are neglected by it.

Nature does not hesitate to urge that a ministry and council of science be established in Great Britain equal in rank and importance to the war council. We fear that it will be a long while before anything would be gained by urging that we should have a minister of science in the Cabinet, but the modest request that the office of director-in-chief of scientific bureaus and investigations in the department of agriculture be created should be seconded by all who are interested in scientific research, or in commercial or agricultural success.

THE GERMAN ZOOLOGICAL SOCIETY.

THERE will be found in the issue of *Die Natur* for August 23d an interesting account of the German Zoological Society by Prof. O. Taschenberg. Many who are familiar with the important work of the Society may not realize that it was only founded in 1890 and has held but six meetings; the first in Leipzig in 1891, under the presidency of Prof. Leuckart; the second in Berlin and the third in Göttingen, under the presidency of Prof. Schultze; the fourth in Munich and the fifth in Strasburg, under the presidency of Prof. Ehlers, and the sixth in May of the present year at Bonn, under the presidency of Prof. Bütschli.

Yet in these few years the Society has contributed to the advancement of zoology in an unusual degree. It has not only published annually its scientific proceedings, but in accordance with its constitution has discussed and carried out plans requiring scientific cooperation. It has secured the establishment of a marine biological station in Heligoland, and has agreed upon and published a system of zoological nomenclature. It will be noticed that in the second of these works the Society has undertaken to legislate not only for Germany, but for the scientific world. It has further proceeded with plans that concern all zoologists. It has secured the republication of the 10th edition of the *Systema Naturæ* of Linnæus and the publication of the *Zoologisches Addressbuch*, to which we have recently called attention. It has now carried into effect the plans for the publication of a complete *Species animalium recensium* (this, its original title, has now been changed to *Das Tierreich*), which, as all zoologists know, is one of the most extensive scientific works ever planned.

The German Zoological Society demonstrates what can be accomplished by proper organization and sets an example to other countries, which, if not followed, will leave to Germany tasks that should be accomplished by international cooperation.

REPORTS ON ENGINE-TRIALS OF 1896.

Le Revue Universelle des Mines de Liége published in its issue of 1896, Volume XXXIV., an account of the work of the Experimental Engineering Laboratory of Prof. Dwelshauvers-Dery in the early part of the current year. The following is a brief abstract of this series of reports:

These experiments were conducted in the operation of the experimental engine of that laboratory for the purpose mainly of ascertaining the effects of draining the steam-chest, while in action, of superheating, of steam-jacketing, and, further, to obtain a measure, on a large scale of operation, of the mechanical equivalent of heat energy.

The latter, the most interesting and important, perhaps, from a general and purely scientific point of view, are also exceedingly important as corroborating, on this large scale of work, the earlier laboratory tests of Joule, and especially of Rowland. The engine is a machine built especially as an 'experimental engine,' and so constructed as to permit the investigation of as many as possible of the numerous problems of steam engineering, while at the same time combining in its design the requisites for practical work of a less scientific character and permitting the instruction of students in the methods of manipulation of steam-engines. The series of researches here described

was made by setting the engine in operation and continuing its action until it had become 'steady' in all its essential conditions of operation, then by means of the steam-engine indicator ascertaining the state, the quantity and quality of the steam *en route* through the cylinders, and measuring the power developed *en gros* and net by the indicator and the Prony brake and by their comparison. A sufficiently complete description of the engine and the details of the accessory apparatus is given in the paper of which this is an abstract.

A delicate and accurate brake system permits the measurement, with great precision, of the quantity of work delivered to the strap of the brake and its comparison with the exact quantity of heat into which it is transmuted and which is carried away by the water employed for cooling it, the weight and change of temperature of which are measurable with similarly satisfactory accuracy. The outcome of the investigation, of which the detailed computations need not be stated here, gave the value of the heat-equivalent as 427.2 kgm. per calorie, as the mean of six experiments, or within one-tenth of one per cent. of that now accepted generally as the result of Rowland's determination under similar conditions of temperature, 426.9.

The figure 426.9, 778 foot-pounds in British measures, has already come to be generally accepted by engineers in their computations relative to the heat-motors and this first exact comparison of the two energies on a large scale, and especially using the steam-engine itself as the apparatus of determination will undoubtedly settle the question of the accuracy of that figure—certainly within the limits of precision demanded by the engineer.

The steam-engine has not usually been regarded as an instrument of precision; but the six trials here recorded gave the figures, the integral numbers being taken, 428, 427, 422, 438, 428, 421, a degree of regularity being thus attained which may appear surprising to one not an expert in this field of applied science. For all steam-engine trials it may be assumed that henceforth the figure adopted for the Carnot heat-thermodynamic equivalent will be taken as 778 foot-pounds per *B. T. U.*, 427 kgm. per calorie.

The investigation of the effect of drainage of the steam-chest during the operation of the engine, with the object of securing perfectly dry steam at entrance into the steam-cylinders, was made in a series of eight engine trials, and at the constant boiler pressure and engine power, as secured at the brake. When the drain cocks were closed, the steam entered the cylinders carrying 5 to 8 per cent moisture; when open, the moisture ranged from 1.54 to to 1.86 per cent. An effective separator at the engine would have undoubtedly had a similar effect, and the trials reported may be taken as measuring the value of that now almost invariable accessory of the high-speed engine in this country. The engine delivered about fifteen horse-power during the trials.

The results of these experiments showed that gain by draining the moisture from the steam before entrance, under the stated conditions, into the cylinders, amounted to the following quantities:

Steam saturated at entrance.—The gain, unjacketed, was 9.29 per cent.; jacketed, 12.08 per cent.

Steam superheated.—A loss was experienced by drainage, of 5.33 per cent., unjacketed; 1.34 per cent., jacketed.

Engine jacketed, economies.—With saturated steam, the economy obtained by jacket action, without drainage, was 26.47 per cent.; with drainage, 28.73 per cent.

With steam superheated, without drainage, the gain was 25.02 per cent.; with drainage, 27.86 per cent.

Steam superheated.—With steam superheated 4° C., the gain obtained amounted to 21.7 per cent., without jacketing and without drainage, 9.07 per cent. with drainage; with jacketing it amounted to 20.16 per cent. without drainage, 9.07 with drainage. With jackets in operation and without drainage, the gain by superheating was 20.16 per cent., and with drainage 7.7 per cent.

It thus appears that separation of the moisture from the entering steam is found to be an important matter; with superheated steam any drainage is obviously, as here shown by direct experiment, wasteful.

GENERAL.

AT the close of the regular Meeting of the American Association for the Advancement of Science at Detroit next year the Association will adjourn to Toronto to welcome the British Association.

THE meeting of Russian naturalists and physicians will in 1897 be held at Kief from the 21st to the 30th of August.

THE annual meeting of the Association of Official Agricultural Chemists will be held in the lecture hall of the National Museum, of Washington, on November 6th, 7th and 9th. The Association of Agricultural Colleges and Experiment Stations will convene on the following day, November 10th.

THE monument to Lavoisier mentioned in the last number of this JOURNAL will be designed by M. Barrias, a member of the *Institut.*

WE learn from *Natural Science* that the principal part of the paleontological collection of the late Mr. William Pengelly, of Torquay, has been presented by his widow to the British Museum (Natural History) and to the Museum of Practical Geology, Jermyn Street. The fossils were obtained chiefly from the Paleozoic formations of Devon and Cornwall, but also comprise a series of bones and teeth from the Happaway Cavern, near Torquay.

ANOTHER serious earthquake is reported to have occurred on the evening of August 31st in the northeast provinces of the main island of Japan, the same provinces that suffered so severely from the earthquake and tidal wave of June 15th, last.

THE iron work of the dome of the Yerkes observatory (which is 110 feet high, 90 feet in diameter, and weighs about 200 tons) is now in position, and it is hoped that it may be possible to move before winter the lenses now ready in the work-shop of Mr. Alvan Clark.

WE regret to record the death of Prof. J. L. Delbœuf, who died at Bonn, on August 13th, at the age of sixty-five. M. Delbœuf, who was professor at Liége, had offered a paper entitled *Sur les suggestions criminelles* at the recent Munich Psychological Congress, but seems to have been attacked with illness on his way to the meeting. We also regret to learn of the death of Prof. Richard Avenarius, of Zurich, one of the ablest of contemporary philosophers and psychologists.

THERE will be held in Madison Square Garden, New York, during the two weeks beginning January 25, 1897, a 'Gas Exposition.' The offices for the present will be located at 280 Broadway, where applications may be made for exhibition spaces, or information of any character relating to the exhibition.

DR. S. RAMON Y. CAJAL, professor of histology and pathological anatomy in the University of Madrid, is the editor of a new journal entitled *Revista Trimestral Micrografica.*

THE first or 'general' part of Dr. Richard Hertwig's *Lehrbuch der Zoologie* has been translated by Prof. George W. Field, of Brown University, and will be published soon by Henry Holt & Co.

THE *Botanical Gazette* states that Prof. J. M. Coulter's Flora of Western Texas, published among the contributions from the U. S. National Herbarium and issued in three parts, has been republished and bound into a single volume. The original edition of the first part had been entirely exhausted.

MR. THOMAS HICK, lecturer in botany at Owens College, Manchester, and the author of papers on sea-weeds and on paleobotany, died in August at the age of fifty-six. *Natural Science* states that, at a meeting held recently at the Manchester Museum, it was decided to collect a sum of money with a view to purchasing his collection of microscopic sections of coal plants and depositing them in the Museum. Any surplus will be devoted to the purchase of a portion of his library, to be given to the Yorkshire Naturalists' Union or to perpetuate his memory in such other manner as may be decided upon by the contributors.

MR. JOHN HOUSTON, a civil engineer and railway constructor, died at Arlington, N. J., on August 30th. He was born in Scotland, but had lived in America for fifty years.

PROF. CÆSARE LOMBROSO, of Turin, in a recent compilation on 'graphology' included three pages from a work on the same subject by M.

Cremieux-Jamin without giving credit to this author. The matter was brought into the courts at Rouen. It was stated that the plagiarism was accidental and shown that M. Cremieux-Jamin had been given adequate recognition in the preface, but Prof. Lombroso was compelled to pay a considerable fine.

In view of the failures to observe the solar eclipse in Norway and Japan, it is fortunate that the party taken to Novya Zemblya by Sir George Baden-Powell obtained very good results. Mr. Shackleton, one of the party, has written to *Nature:* "I obtained about eight photos during totality. The most successful are those at the beginning of the eclipse, also at the end and the long exposure near mid-totality. The two photos near the beginning of totality are very interesting; the one nearest the time of the beginning of totality shows, I think, without doubt, as many bright lines as there are in the Fraunhofer spectrum with the same instrument; so in all probability we have succeeded in photographing the 'reversing layer.' The plate at the end of totality also shows a great many lines, but not as many as the beginning; probably they are the same as those photographed by Mr. Fowler in the metallic prominences of 1893—certainly most of them are. The long exposure near mid-totality gives a good ring at 1474 K, and also one near K (3969λ), and several other fainter ones. The spectra are not so extensive in ultra-violet lines as those of 1893, probably because of the cloudy state of the sky. The corona-photos have also come out very well."

According to *The Lancet* a new meteorological observatory has recently been erected at Edinburgh, about half way up Ben Nevis. The principal objects are to determine, with greater precision than has hitherto been possible, the extent to which anticyclones descend on the mountain, and to obtain records of temperature, pressure and humidity for comparison with those noted at the summit and at Fort William. With this knowledge the inquiry into the character of coming cyclones as regards their shallowness or depth, and of the occupying anticylones, will be greatly extended, particularly in view of the important practical question of forecasting the weather. The instruments to be used are a new Fortin barometer, with extended scale adapted to the height by Mr. Casella, of London, dry and wet bulb, and maximum and minimum thermometers; rain guage, and instruments for measuring solar and terrestrial radiation. The erection of the new laboratory has been promoted by the Meteorological Society, and the observations are to be made and recorded by Mr. Muir, one of the assistant masters in the Edinburgh High School.

At the Electrical Congress held at Geneva from August 4th to 8th the magnetic units provisionally adopted by the American Institute of Electrical Engineers were rejected and no units nor names were adopted. The Congress, however, adopted a photometric unit entitled *bougie décimale*, based on the Hefner amyl-acetate lamp.

We learn from *Die Natur* that Dr. B. Hofer, privatdocent of zoology in the University of Munich, has been elected to a newly founded chair of fish culture and the diseases of fishes in the veterinary school of Munich. This would seem to be the first academic recognition of this subject and it would be an advantage if the example were followed in America, where there are many openings for students having a scientific and practical knowledge of the subject.

The Botanical Gazette calls attention in an editorial article to the neglect of foreign literature by German botanists. Dr. Correns explains, in the *Botanisches Centralblatt*, that he did not know of an article by Prof. MacDougal because *The Botanical Gazette* is not to be found in Tübingen. It is probable that American scientific work will not be adequately recognized on the continent of Europe until an international method of indexing and abstracting scientific literature has been devised. In the meanwhile, although the orderly advance of science is obstructed, American students have an advantage over their foreign colleagues similar to that of him wearing 'the invisible cap.'

A correspondent of *The Lancet* writes that Lord Kelvin's remarks at the banquet given in his honor in July last have led to some misun-

derstanding in certain quarters, and M. de Fonvielle, a distinguished scientific journalist, has written to Lord Kelvin, congratulating him upon the 'failure of the atomic theories.' In reply Lord Kelvin expressed his regret at the misunderstanding, and goes on to say: "I do not allude in this passage to anything which I am in the habit of teaching either in my classes or in my published works. I am as much convinced as ever I was of the absolute truth of the kinetic theory of gases. All I know is I have not succeeded, in spite of fifty years of effort, in understanding more about the luminiferous ether or the manner in which it operates in regard to the electrical and magnetic forces. It is on this point I remain as ignorant as I was fifty-five years ago, when I first became convinced that the ether operated essentially in all these actions."

PROF. H. F. OSBORN has contributed to the September number of *The Century* an account of 'Prehistoric Quadrupeds of the Rockies,' well calculated to impress on the reader the interest and importance of paleontological research. The American Museum of Natural History has collections of great value, gathered by Prof. Osborn, Dr. Wortman and others, and under their direction Mr. Charles Knight has prepared a series of water-color drawings designed to give an idea of the appearance of the extinct animals in their natural surroundings. These were exhibited last winter at the reception of the New York Academy of Sciences and are undoubtedly the most life-like reproductions hitherto executed. Nine of the drawings have been reproduced on a large scale, and accompany Prof. Osborn's article in *The Century*.

M. DELEBECQUE has communicated to the Paris Academy a description and explanation, by M. Forel of Lausanne, of the phenomena known as the *Fata Morgana*. These have long been observed at the Straits of Messina and have been described by Humboldt and others. The phenomena consist in an apparently great enlargement, in a vertical direction, of the rocks, buildings, etc., on the opposite side of a lake or strait. M. Forel finds that it is not a real enlargement, but a number of different images, some erect and some reversed, and attributes it to complex mirage.

WE regret having printed a note in the last issue of this JOURNAL in which it was assumed that an article by President Jordan in the September number of *Appleton's Popular Science Monthly* might have been intended seriously. It is a satire on 'impressionist physics,' and ought to be so recognized by every one, even apart from the signature of President Jordan. It is, however, impossible to parody, other than by republication, much that has been written on this subject, and President Jordan will probably receive letters asking for admission to the 'Alcade Camera Club.'

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of the late Martin Brimmer, of Boston, Harvard University will receive $50,000 on the death of his widow.

THE six buildings of the New York State Veterinary College of Cornell University have been completed and the laboratories and museums are being fitted up.

BY private gifts, a Japanese fellowship in economics has been established at the University of Wisconsin, and Mr. M. Shiozawa, of Tokyo, Japan, has been elected to the fellowship for the coming year. A second fellowship in economics has been arranged for 1896–97 only, to be held by a graduate of Rockford College, and Miss Mary A. Salvin has been elected to the fellowship.

THE forty-third report of the Department of Science and Art of the Committee of Council of Education of Great Britain shows that the expenditure of the Department was £745,470 for the year 1895. Of this amount over £150,000 was in direct payments to encourage instruction in science. The number of visitors during 1895 was 1,040,628 at South Kensington and 355,248 at Bethnal-green, a decrease of more than a quarter of a million from the year before.

GEORGE T. WINSTON, President of the University of North Carolina, has been elcteed President of the University of Texas.

PROF. NATHANIEL SCHMIDT, of Colgate University, has been appointed to the new chair of Semitic language and literature, recently en-

dowed by Mr. Henry W. Sage in Cornell University.

DR. FRANZ HOFMEISTER, professor of pharmacology at Prague, known for his researches in physiological chemistry, has been called to the chair at Strasburg, vacant by the death of the late Prof. Hoppe-Segler.

PROF. F. F. JERISMAN has resigned the chair of hygiene in the University of Moscow.

DISCUSSION AND CORRESPONDENCE.

THE LICK REVIEW OF 'MARS.'

HAVING sought to throw discredit on Mr. Lowell's work, almost before it was begun, some two years ago, the Lick Observatory now renews the attack in Prof. Campbell's review of Mr. Lowell's book. Formerly it decried the work because the theories upon which it was started were too original; now it attempts to seize the credit of the results and calls the theories 'mostly old.' Such a remarkable act of appropriation cannot be allowed to pass unnoticed.

In order to unmask at once the character of the article, we will take first the two points in which the writer sums himself up.

1. Prof. Campbell asserts that of the two leading faults of the book, one is: 'that there should be so many evidences of apparent lack of familiarity with the literature of the subject' on Mr. Lowell's part; and he introduces, quotations at great length from a translation by Prof. W. H. Pickering, of Schiaparelli's work, to which translation he professes his obligation. Of this it is only necessary for us to say that the translation in question was made at the Lowell Observatory, a fact which Prof. Campbell neglects to mention, although the fact was so printed on the paper from which he quotes. We are willing to have the Lick indebted to us for its knowledge of Schiaparelli's work, but it must not suppose us ignorant of our own translation to which its knowledge is due. As the public could not have been expected to know whose the translation was, while we, on the other hand, could not have failed to do so, we are in doubt whether to wonder most at the simplicity or the bare-facedness of such a proceeding.

2. The writer asserts, as the other fault, that the observations were not continued long enough to support the conclusion of seasonal changes on the planet. If he will read again our translation of Schiaparelli he will find that that eminent observer has noticed seasonal changes for years and that what our observations disclosed was not only the fact of changes, which they corroborated, but the character of the changes and the process of their development, thus furnishing an important link in the chain of evidence for Mr. Lowell's theory.

3. With regard to the literature of Mars contributed by the Lick and referred to in the article the succeeding points will show whether that literature was unknown to Mr. Lowell or whether its unimportance made mention of it unnecessary.

4. We will begin with the Lick attempt to claim the discovery of canals in the dark regions for Prof. Schaeberle in 1892, because the latter saw 'streaks' there then. Not only did Prof. W. H. Pickering and Mr. Douglass discover these same 'streaks' at Arequipa, of which fact the writer of the article is apparently ignorant, but Mr. Douglass' discovery, at Flagstaff, in 1894, was not of 'streaks,' but of canals, in the technical sense in which that word is used for Mars; and it is to the detection of these 'canal' peculiarities that the importance of the discovery is due, since it is these peculiarities that impart an artificial appearance to the entire system of canals. The difference between 'streaks' and 'canals' in the dark regions is of exactly the same kind as the difference between the streaks seen in the light areas by Madler, Dawes, Kaiser and others, prior to Schiaparelli's discovery of them as 'canals.'

5. The North Polar Sea was seen by Schiaparelli; the South Polar Sea has been drawn by many previous observers, but not recognized as such. Its limits and the proof of its character are due to Prof. Pickering's polariscope observations at this observatory. Its function in the climatology of Mars was first thoroughly discussed by Mr. Lowell in his book, and this is the precise meaning of his words, 'never distinctly noted or commented on before.'

6. The Lick article asserts that the first irregularity on the terminator was seen at the Lick Observatory, in 1890, but it omits to mention

that it was a casual visitor who detected it, so that to this visitor, and not to the Lick staff, belongs the discovery. What such an outsider's discovery betokens about the efficiency of the staff it is not our purpose to remark. The value of our observations consisted in their great numbers, in the fact that depressions were seen for the first time, in the systematic search made for them all around the planet and in the information they have yielded in regard to its meteorology and topography. Of Prof. Campbell's attempt to criticise the discussion of these observations it is useless to speak, as, owing to his ignorance of the original data, his guesses on the subject are not important.

7. The Lick article asserts that the vegetation theory was suggested by Schiaparelli. If the writer will read, once more, our translation of Schiaparelli he will see that such is not the case, and that not only is Schiaparelli speaking solely of the canals, but that he rejects the mere suggestion of vegetation, nor does he hold it to-day. Nor is this all, for Prof. W. H. Pickering suggested the same theory many years before.

8. The attempt to disparage Mr. Lowell's discovery that the Martian longitudes came to the meridian twenty minutes behind time, by attributing it to Prof. Keeler, will be seen to be an error, by any one who cares to consult the original papers of both.

9. As to any knowledge at the Lick Observatory of a Martian atmosphere, it has been purely negative, Prof. Holden going so far in an article, in the *North American Review* for 1895, entitled 'Mistakes about Mars' as to declare that the opposition of 1894 would be memorable for having proved an absence of atmosphere. We may let Holden's Mistakes about Mars speak for themselves.

We could go on in this manner, but we have shown enough. We should not have noticed an article like the one before us had it not been an attempt on the rights of property, rights at least as sacred in intellectual matters as in those more material ones which the laws protect.

A. E. DOUGLASS,
For the Observatory.

LOWELL OBSERVATORY, FLAGSTAFF, ARIZONA, August 14, 1896.

COMMERCIAL MICA IN NORTH CAROLINA: THE STORY OF ITS DISCOVERY.

IN an interesting and instructive article on Mica and Mica Mining, published in the *Popular Science Monthly*, for September, 1892 (Vol. XLI., p. 652), C. Hanford Henderson makes the following statement concerning the discovery of commercial mica in North Carolina:

"The location of the mines has been largely accidental. So far as I have been able to learn, the first one opened was the Sinkhole Mine in Mitchell county. The spot was marked by the existence of trenches, many hundred feet long in the aggregate, and in places fully twenty feet deep. Large trees growing on the *débris* indicated that the workings were very ancient. It was supposed that they had been for silver; and when the trenches were re-opened, at the close of the war, the search was for that metal and not for mica. Silver seems to dominate in the Carolinian dream of mineral wealth, when it is, of all such dreams, the one least likely to be realized. The search for silver being unsuccessful, the mines were again abandoned. The mica that had been thrown out was left on the dump, and soon advertised the real character of the mine. A stock driver, passing that way, carried a block of it to Knoxville, where it attracted the attention of men acquainted with its value. They investigated the matter, emigrated at once to Mitchell county and began systematic mining for mica. As the mineral was then selling for from eight to eleven dollars a pound, the rewards were considerable, and much enterprise was shown in the development of the industry."

This statement was also published in the *Engineering and Mining Journal*, for January 7, 1893 (Vol. LV., p. 4), as a part of an abstract of the above paper.

During the summer of 1880, as the assistant of the late Prof. W. C. Kerr, State Geologist of North Carolina, and in the capacity of a special agent of the Tenth Census, I visited the various mica localities of the State, for the purpose of securing statistics and such other information as was deemed necessary in making up his report. While in Bakersville I made careful inquiry concerning the origin of the

mica industry, and by reference to my notes taken at the time, and the accompanying letter of ex-United States Senator Thos. L. Clingman, received in August of that year, I am in a position to throw more light upon the subject.

The story then current in Bakersville was quite similar to that above given. On July 27th I had a conversation with Mr. C. T. C. Deake ('Old Roan'), editor and proprietor of the 'Roan Mountain Republican,' a very intelligent and well-informed citizen, who said in substance: Gen Clingman while prospecting for *silver* at the Sinkhole Mine threw out mica.* A wagoner took some to Knoxville, Tenn. Here Messrs. Heap and Clapp were engaged in the hardware business. They knew the value of mica in New York. Clapp came first and leased the Sinkhole and other mines. This was about '70.

A few days later Mr. T. G. Heap, the surviving member of the firm, informed me that his attention was called to the existence of mica at the Sinkhole *silver* mine by a peddler of county rights in a broadcast wheat-sowing machine. This individual, 'footing it,' through the country, came to the Sinkhole Mine, and seeing the bright, shining mica brought a sample to Knoxville, where he exhibited it on the street. No one recognizing its value save himself, he immediately dispatched his partner, Clapp, to lease the mine, which had been forfeited by the previous lessee (see Gen. Clingman's letter), and the first work was done 'on the day of the great eclipse, 1869.'

That "silver seems to dominate in the Carolinian dream of mineral wealth" was amply demonstrated during my trip through the Blue Ridge country sixteen years ago. As Henderson states, it was supposed that the prehistoric trenches of Mitchell and other counties were abandoned *silver* mines. That they were not has been conclusively shown by both Prof. Kerr and Gen. Clingman. The latter in his letter states positively that his object in opening the prehistoric mine at William Silvers, known as 'Sinkhole,' was for the purpose of obtaining *mica*.

*Based upon this and similar statements I, too, expressed the opinion that the search was for *silver*. See an article on 'Mica Mining in North Carolina,' published in the Mining Record, N. Y., July 2, 1881.

The association of silver with the excavations of this particular locality may have been due to the fact that they occurred on the property of a Mr. Silvers, and that they should eventually become known as old *Spanish silver* mines is not, at least, impossible, considering the widespread tradition that the early Spanish explorers reached western Carolina.

Gen. Clingman's letter is as follows:

ASHEVILLE, August 18, 1880.

DEAR SIR: Your favor has been received, and I will, with pleasure, make you a brief statement with reference to the mica operations in our own State.

During the summer of 1867, when in New York, I learned that mica, owing to the failure of supplies from New England, had become very scarce in the market. Prof. A. Trippell told me that he had for certain parties paid $8 per pound for ordinary mica.

Knowing that it existed in several localities in North Carolina, of good quality, I, on my return, made examinations in several of the counties. I commenced with Cleveland, on the east, and passed through Rutherford, Burke, and McDonald east of the ridge. I then examined the northeastern part of Buncombe, south of the Black Mountains, and gave a good deal of time to Yancey and Mitchell. I caused work to be done in Cleveland, Burke, Yancey and Mitchell. I became satisfied that the latter county held out the best prospects for a good supply of the mineral.

I therefore returned to New York, and made an arrangement with Messrs. Sloane and Menden, then doing business at 113 Liberty street. They agreed to work all such mines as I had secured or might secure, and pay me one-half of the net profits. Mr. Menden, in January, 1868, visited with me some localities east of the Ridge, and we had some mica taken out in Cleveland. Owing to the severity of the winter weather, he postponed his visit to Mitchell and Yancey until the opening of the spring. In May we went into Yancey and Mitchell to the Ray Mine and some others. Owing to the roughness of the roads, however, he declined to go with me to the Silvers and

Buchanan Mines and decided to abandon the business. It may seem singular, but nevertheless it is the fact, that on my previous hasty examination I had selected what have since proved the three best mines, viz.: the Ray Mine in Yancey, and the Silvers, or Sinkhole, and the Buchanan Mines of Mitchell.

After Messrs. Sloane and Menden declined prosecuting the engagement, not being willing to abandon it entirely, in the summer of 1868, I caused some work to be done at the William Silvers, or Sinkhole Mine, as it has since been called. The shafts I had sunk and the tunnels driven showed an abundance of good mica. Being obliged to leave, I contracted with the foreman, who was managing the workmen employed, to save the blocks of mica, which were more than sufficient to pay the expenses of the operation. I learned, however, that soon afterwards he, having heard that some members of his family were sick, abandoned the work and left the mica lying on the ground. As I was then in very bad health, I did not feel able to superintend the work myself, and [as I] was not in condition to employ suitable agents, I decided to abandon the enterprise and surrendered my contract to Mr. Silvers and told him to make some new arrangement.

Mr. Heap, who has been the largest operator in the mica business, informed me that he had been induced to go into the business by this circumstance. A horse driver, on his return, knocked up one of the blocks of mica left on the ground and carried it to Knoxville in the autumn of 1868. On seeing it, Mr. Heap made inquiries as to the locality, obtained a lease from Mr. Silvers and commenced operations there. His success encouraged others to embark in the business, Mr. Garrett Ray being one of the first to begin in the early part of 1869, at a place where I had taken some specimens. The working gradually spread to other localities in these and other counties.

For additional and fuller information, I refer you to a publication of mine in the printed volume of my writings and speeches which you can find in the libraries at Chapel Hill. It begins on page 130, headed *Old Diggings for Mica, etc.* The name of Mr. Silvers is misprinted there. That publication will give you, probably, the additional matter you desire. It was originally published in the *Asheville Expositor* at the time of its date, April 8, 1873.

* * * * * *

Hoping that this statement may be sufficient for your purpose, I am

Very truly yours, etc.

T. L. CLINGMAN.

Prof. F. W. Simonds.

From the above letter it will be seen that the location of the mines was not 'largely accidental;' on the contrary, that Clingman made the preliminary investigations for a purpose, which was to discover commercial mica, and that he succeeded. But, as has often happened, he failed to grasp the prize almost within his reach. Ill health and a want of capital caused him to abandon the enterprise, and strangers, profiting by his preliminary work, reaped a substantial reward.

FREDERIC W. SIMONDS.

SCHOOL OF GEOLOGY,
UNIVERSITY OF TEXAS, July, 1896.

SCIENTIFIC LITERATURE.

Manual of Lithology: Treatment of the Principles of the Science with Special Reference to Megascopic Analysis. By EDWARD H. WILLIAMS, JR., E. M., F. G. S. A., Professor of Mining Engineering and Geology, Lehigh University, South Bethlehem, Pa. With six plates. Second Edition. First Thousand. New York, John Wiley & Sons. 1895.

In reviewing this work particular attention ought to be paid to its objects and to the system of education that has given it birth. The criticisms may seem severe, but they are aimed only at educational methods that the reviewer considers radically wrong, even if circumstances force him to give seeming countenance to them.

The principal points here noted are two: (1), the neglect of considering the student in preparing a text-book, and (2) the habit of spreading instructors over too extended a field.

A text-book to be of practical use to students must be clear, concise and accurate in its statements. In an observational science it should indicate in the most unmistakable language the

appearances of the objects, their points of difference and their resemblances. The beginner ought to have the way smoothed off for him and every turning in the road explained. The discipline for the student should not come in the labor of mastering the principles of the science, but in applying them. Time is too short and too valuable to require the learner to spend all his time in clearing his path from the stumps, stones and other rubbish the instructor has left there, either from incompetence, ignorance or indolence. It is this unnecessary rubbish left in the way that wastes the time of our pupils and causes so many of them to graduate before they have really learned anything so that they can apply it.

The preface to Williams' Manual informs the reader in substance that the book is designed to teach beginners to distinguish the different kinds of rocks by means of the naked eye and ordinary lens, and to inform engineers about the various uses of rocks.

Looking at the first object—the student's use —the following sentence, culled from many, will give an idea of the lucidity of expression employed: "It may also be advanced that it does not require a greater amount of heat to metamorphose the walls in the one case than in the other, and that it is as easy to suppose the walls heated before the stoppage of the flow, either by the length of time during which the flow passed or from the fact that the whole region was heated to a point just below metamorphism (by orogenic or other causes) before the fracture and intrusion took place, and that the intrusive supplied the needed increment for metamorphism" (p. 3). This doubtless was one of the 'hot times' frequently heard of, but never before known to produce geological metamorphism through their length. This explanation will not only clear matters up for the beginner, but will assist the physical geologist in solving some of his most difficult problems.

How much attention could the author have paid to the needs of students, when, alone of all the manuals relating to the microchemistry of minerals, he refers to the French one of Klément (misspelled Klémert) and Renard, a publication that has long been out of print, and so rare that the reviewer has not been able to secure even a single copy after years of endeavor.

The only proper place mineralogy, as such, has in a text-book of lithology is when the space is devoted to pointing out the modes of occurrence of the minerals in rocks and the methods employed for their macroscopic identification.

In this book the first is briefly done and the latter hardly at all, while the chief portion devoted to mineralogy falls into the category usually known as 'padding.' The part of the work relating to the general definitions is its most valuable portion, although the statements here are deficient in clearness and precision, while much unnecessary matter has been introduced.

In the rock descriptions what beginner could macroscopically identify an obsidian by being told as its definition that it was 'a compact glass of varying color and luster, of a high acidity, and with content of chemically combined waters never more than one per cent.' (p. 114)? Or how is the learner to distinguish amphibolite from hornblende schist when the massive and schistose states occur almost in the same hand specimen, if he is guided by these definitions? 'Amphibolite, a granular aggregate of dark green to black hornblende with more or less quartz, and sometimes chlorite.' 'Hornblende-schist, a granular and schistose aggregate of the above minerals with similar silica and specific gravity.'

Throughout the book the descriptions and definitions of the rocks are not clear and accurate for macroscopic work, so that the beginner can find any clues to lead him on through the labyrinth. No directions are given to show him how he may avoid errors, and the characteristic appearances of the rocks are almost unnoticed.

It is such teaching as this, the reviewer believes, which crowds a student's head with a mere jumble of words, but leaves him destitute of any real knowledge of their application.

Although this is the second edition, the critic cannot see that the work has any use or place in the class room or laboratory. He regards it as one of the most worthless manuals on macro-

scopic lithology he has ever seen, and wonders how such a book could have been written by any man who had the slightest comprehension of a beginner's needs or who ever spent a day in a lithological laboratory.

Most of the plates that illustrate the book are of no use to the beginner, since, as a rule, no one except an expert could tell what rock they were intended to represent. The craze for photographic illustration in students' text-books, started by Rosenbusch, is one that should be frowned upon, in every case, except when the characters stand out boldly. The true way to assist the student is to have the plate show him what he is to look for. For this purpose it needs to be diagrammatic and exaggerated, so that the salient points will be grasped readily. In the present system the picture is commonly far more confusing than the original. A text-book is one thing, a volume illustrating original investigations another. The plates, poor as many of them are, in Harker's excellent little book, are of far more real value to a beginner than are any series of photographic prints ever published.

Turning to the engineer's side of this work, he will find it limited to a trifle over eight pages. This contains, for its space, quite a little useful information, but it is altogether too brief to be of much value. It is a great pity that this part could not have been enlarged and the remaining portions condensed.

No attempt is here made to point out the lame system of classification, the evident want of accurate acquaintance with lithological literature, or even with the rocks themselves. The reviewer's duty is not to criticize the book as a scientific treatise, but as a text-book for students wishing to obtain a working knowledge of rocks. The critic can but consider the work as a paste pot and scissors production, in which the materials were culled without judgment or real knowledge ; and is the natural and legitimate result of a system in this country which allows in a university one man to hold two chairs, each of which demands all of his time and energy, however able he may be. Particularly is the system wrong when the two chairs are so diverse as mining engineering and geology. The subject of geology alone is too vast even for a Baconian genius to do justice to it. It contains within its limits two parts or two sciences so different and so great that no college or technical school, and far less a university, can hope for a creditable standing in the geological world, which permits its geological department alone to be covered by one man, however eminent he may be. The butter has to be spread too infinitesimally thin for such a tremendous slice of bread.

The author of the work in question is not to blame, since nothing different ought to, or could, have been expected under the circumstances.

The only thing that the work can here be recommended for is, as a convenient manual in English, for the experienced lithologist to refresh his memory on some points.

M. E. WADSWORTH.

MICHIGAN MINING SCHOOL.

AMERICAN LINGUISTICS.

Langue Tarasque; Grammaire, Dictionaire, Textes. Par RAOUL DE LA GRASSERIE et NICOLAS LEON. *Bibliothèque Linguistique Americaine.* Tome XIX. pp. 293, Paris, Maisonneuve. 1896.

Die Maya-Sprachen der Pokom-Gruppe. ZWEITER THEIL. *Die Sprache der K' ekchi Indianer.* Von DR. OTTO STOLL. Pp. 221. Leipzig, Kohler. 1896.

The above are unusually valuable additions to the science of American linguistics. They present two North American languages hitherto little known to scholars, by careful analyses, according to the most approved methods of modern research.

The Tarascas were the native population of the State of Michoacan in Mexico when it was first discovered by the whites. They belonged among the semi-civilized tribes, though the language they spoke had no relationship to the Nahuatl, nor to any other on the continent. They erected important structures of stone, brick and mortar, and were sedentary and agricultural in habit.

Their language is characterized by the present writers as 'elegant and harmonious, rich and poetic.' Its phonetics are not difficult and its

morphology and syntax, though presenting some peculiarities, are not excessively complicated. It is incorporative in a high degree, a unique trait of its infixation being the incorporation in the verbal stem not only of the object, but of a generic particle which includes it. Another oddity is the attraction of the number of the object to that of the subject, as if we were to say, 'I teach him,' and 'we teach hims.' The grammatic analysis is ably carried out. The dictionary, taken from that of Father Gilberti who wrote in the sixteenth century, occupies 150 pages, and the texts, mostly religious and therefore of secondary value, are sufficient to show how Europeans wrote the tongue. A bibliography is added and a slight sketch of the history of the tribe. Both the authors are well known by their previous valuable contributions to American studies.

The work of Dr. Stoll is a continuation of his fruitful contributions to the ethnography of Guatemala. The K'ekchi is a dialect of the Mayan stock still spoken in the department of Vera Paz, Guatemala, by about 85,000 natives. It stands in near relation to the Quiche-Cakchiquel group of the stock, but is sharply contrasted with these idioms by the wearing away of many of the forms, especially in suffix verbal derivatives. This suggests at once that with respect to them it is of modern formation.

The author devotes about a hundred pages to the grammar, which he analyses with the same thoroughness which characterized his former essay on the Pokomchi and the Ixil dialects. The vocabulary presents over three thousand words in correct phonetic form, based on a variety of authorities.

The volume closes with thirty pages devoted to the Uspanteca dialect. This is spoken in and near the village of San Miguel Uspantan, and was formerly included in the Quiche group; but Dr. Stoll shows that it is more closely connected with the Pokom group.

The interest attaching to this work is enhanced by the recent investigations into the archæology of the K'ekchi territory. Their ancestors probably erected the remarkable buildings at Copan, Quirigua and Tzac Pokoma; their pottery belonged to the most perfect on the continent; and the numerous mounds and sites throughout their land still offer most attractive fields for exploration.

D. G. BRINTON.
UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC JOURNALS.

PSYCHE, SEPTEMBER.

A. P. MORSE continues his notes on the New England Tryxalinæ by a consideration of the genera Chloealtis and Stenobothrus, one species of each. F. L. Harvey describes and figures a Thysanuran from Maine, possibly distinct from Packard's *Anoura gibbosa*. H. G. Dyar gives the life history of *Ichthyura strigosa* Grote. S. Henshaw adds a new instalment of his biblographical notes, being a list of the entomological articles in *Garden and Forest*, 1892–1895. The Proceedings of the Cambridge Entomological Club follow, the principal point of which is found in A. G. Mayer's account of the pigment in lepidopterous scales.

NEW BOOKS.

The Biological Problem of To-day. DR. OSCAR HERTWIG. Authorized Translation by P. Chalmers Mitchell. New York, The Macmillan Co. Pp. xix + 148. $1.25.

Text-book of Paleontology. CARL A. VON ZITTEL. Translated and Edited by Charles R. Eastman. Vol. I., Part I. Pp. 352, 593 Woodcuts. New York and London, The Macmillan Co. $2.75.

A Geographical History of Mammals. R. LYDEKKER. Cambridge, University Press; New York, The Macmillan Co. 1896. Pp. xii + 400. $2.60.

The Principles of the Transformer. FREDERICK BEDELL. New York and London, The Macmillan Co. 1896. Pp. iv + 416. $3.25.

The Gas and Oil Engine. DUGALD CLERK. Sixth edition revised and enlarged. New York, John Wiley & Sons. Pp. xii + 538.

Modern Optical Instruments. HENRY ORFORD. London, Whittaker & Co.; New York, The Macmillan Co. 1896. Pp. vi + 100.

A Catalogue of 16,748 Southern Stars. LIEUT. J. M. GILLISS. Washington, Government Printing Office. Pp. xxxi + 420.